COST-OF-ILLNESS METHODOLOGIES FOR WATER-RELATED DISEASES IN DEVELOPING COUNTRIES

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COST-OF-ILLNESS METHODOLOGIES FOR WATER-RELATED DISEASES IN DEVELOPING COUNTRIES

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by

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Related WASH Reports

Health Benefits from Improvements in Water Supply and Sanitation: Survey and Analysis of the Literature on Selected Diseases. WASH Technical Report No. 66. July 1990.

The Value of Water Supply and Sanitation in Development: An Assessment of Health-Related Interventions. WASH Technical Report No. 43. September 1987.

Cost-Effective Approaches to the Control of Dracunculiasis. WASH Technical Report No. 38. September 1986.

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EXECUTIVE SUMMARY

This report develops a methodology for the use of cost-of-illness (COI) approaches for water-related projects in developing countries. The COI approach described focuses on potential health benefits from water supply and sanitation interventions and takes into account potential direct cost savings, in the form of avoided medical care expenses, as well as potential indirect cost savings, in the form of productivity gains in a population no longer affected by the disease or illness. Data from accepted economic methodologies are increasingly seen as necessary in the policy process for justifying such interventions. Proper application of COI studies could contribute to this process.

Implementation of COI health benefit studies involves important precursor and follow-up steps. These include (1) defining the context and scope of the study, (2) determining the health effects of the intervention, (3) assessing data characteristics and availability, and (4) presentation of results to policymakers. COI studies conducted without proper "ground work" and adequate follow-up will likely prove irrelevant or ineffectual. The use of a multidisciplinary approach in all aspects of the study, including the design, implementation, and presentation/follow-up, is important. Disciplinary areas that should be involved if at all possible include epidemiology, biostatistics, survey research, economics, and policy analysis. In addition, the "investment" of decision makers in the analysis and its results should be encouraged from the beginning through close collaboration.

The report provides a step-by-step guide to the "best case" data needs and calculations for a COI-based study in developing countries. The methodology addresses such issues as disease seasonality and its impact on production, access to medical care, substitutability of labor, and impact of other diseases, among other factors. Detailed tables specifying data needs and flow charts describing the analytic steps are included. Spreadsheet table shells are provided in an appendix as a guide to how data might be collected and arrayed. COI studies can be implemented at various levels—local, regional, and national. Data limitations (and resource limitations on the collection of new data) are likely to be highly constraining factors on the implementation of fully developed COI studies in developing countries. Thus, the report discusses data considerations and suggests ways to overcome data gaps or, at a minimum, to make the gaps and resulting assumptions explicit.

In addition to a detailed description of the proposed COI methodology, the report includes, as an appendix, a detailed review of recent theoretical studies and applied work in developing systematic approaches to conducting economic impact studies of health programs in developing countries. Weaknesses and caveats identified in the studies, as well as lessons learned in them, were incorporated to the extent possible into the proposed methodology.

Important next steps for this research include the trial application of the proposed COI methodology to an actual country situation. A field test would provide critical information not available from the literature-review-and-consultation approach of this task regarding the feasibility of the methodology.

Finally, a substantive issue for future investigation became apparent in the development of the COI approach for this application. The effect of an intervention strictly in terms of its impact on disease incidence and prevalence may not be as critical, from an economic standpoint, as its effect on disease severity. That is, when mild cases of the disease have little overall economic effect, shifting the distribution of the number of cases toward more mild cases (and fewer severe cases) may indicate a desirable health outcome, even with unchanged overall incidence or prevalence. Specific interventions, however, are often judged primarily on the basis of their impact on incidence or prevalence. Economic considerations could result in focusing the assessment of program effectiveness more on the impact of the intervention in reducing case severity to a point that the population's productivity is minimally affected, even without a significant effect on disease incidence or prevalence. Further investigation of this issue is warranted.

1

INTRODUCTION AND BACKGROUND

1.1 Task Origin

This task originated in discussions with the USAID health officer in Pakistan following work on a WASH study of guinea worm program implementation planning and cost-effectiveness (Paul 1988). In that study, a human capital, incidence-based cost-of-illness (COI) approach similar to that described by Hodgson and Meiners (1982) was used to estimate productivity losses (and therefore potential economic gains) due to guinea worm disease. The existence of current epidemiologic data for guinea worm, and the special characteristics of the disease itself and the areas where it is endemic in Pakistan, allowed many simplifying assumptions. Those assumptions, in turn, allowed a straightforward and credible analysis of the costs of the disease to the local economy, as well as realistic estimates of the potential benefits of eradication. Details of the COI approach used for the Pakistan guinea worm program are provided as part of Appendix A.

Perceiving a need for more rigorous arguments to bolster investments in health interventions, the USAID/Pakistan health officer suggested during the debriefing on the guinea worm task that a new activity be initiated to extend the COI concepts used to study guinea worm in Pakistan to other diseases, taking into account models and theories developed elsewhere.

As a preliminary step in establishing this current task, the WASH Project convened a workshop in Arlington, Virginia, on October 18, 1989. The purpose of the workshop was to discuss COI methodologies, extensions, and applications in developing countries in order to focus the task and ensure that it reflected current emphases.

1.2 Statement of the Problem

Amid a general scarcity of resources in developing countries, health sector projects (including water supply and sanitation) often have a difficult time competing for funds on the basis of economic arguments. Provision of health services may be seen more as a "social benefit" than as an input to the economic well-being of a country. This is because host country policymakers and development planners often have insufficient information on the magnitude of the effects of illness and disease on the economy and the economic benefits that could be derived from successful health interventions. Health services, therefore, are often among the last to be funded or among the first to be cut when allocating scarce budget resources to projects designed to benefit the national economy.

Review of the literature yields substantial theoretical and applied work in developing systematic approaches for conducting economic impact studies for diseases in developing countries. However, no consensus exists on an overall approach. A number of overviews have been prepared describing and critiquing the various approaches. The brief description below and the complete literature review in Appendix A provide a further synthesis of these reviews in order to establish a basis for a methodology to assess the economic impacts of disease in developing countries.

Approaches to economic studies of health have evolved substantially over the past 40 years. According to Mills (1985), the early (1950s to 1970s) economic studies of tropical diseases and the health programs designed to reduce their incidence estimated the effects of a disease on the economy using the human capital approach. In this approach, benefits of disease reduction are defined as the increased productivity possible because of reduced mortality, morbidity, and disability attributable to a disease. Other economic effects of health programs that were mentioned and occasionally measured in these studies were population growth, increasing land availability for farming, and reduced health care costs.

In the 1970s, micro-level studies of the relationship of health and productivity showed the relationship to be more complex than the earlier studies had assumed. Additionally, early cost-benefit studies were criticized for failing to value nonwage labor, such as household production, adequately. These difficulties with estimating true productivity effects sparked interest in cost-effectiveness analysis (CEA) as a substitute for cost-benefit analysis (Mills 1985). In CEA the health benefits are measured in physical units, such as cases of disease avoided or healthy days of life gained, and no attempt is made to estimate the larger effect of those health improvements on the economy.

For policy purposes, however, CEA has its limitations. It is designed primarily to help the decision maker to decide which programs can achieve a desired health improvement at the least cost. For example, if Program A and Program B both reduce the incidence of measles by 50 percent, CEA will enable policymakers to choose the least expensive (i.e., most cost-effective) program. When comparing programs with different-sized health improvements, however, CEA can be very misleading. For example, consider Project A, for which an expenditure of $1 results in avoiding one serious injury, and Project B, for which an expenditure of $200 results in avoiding 100 serious injuries (Hills and Jones-Lee 1983). Looking at the cost per serious injury avoided, Project A is better ($1/serious injury avoided) than Project B ($2/serious injury avoided). However, unless a serious injury is valued at less than $2, Project B is clearly preferable because it will avoid an additional 99 injuries. Thus, implicit valuation of the benefits has to occur to complete CEA comparison of programs with effects of different magnitudes. To be able to compare development programs with different types of effects, for example a transportation program designed to save travel time (Howe 1976) with a health program designed to reduce morbidity from illness, explicit valuation of the benefits along a common metric is essential.

1.3 Objective for Task

Properly designed, implemented, and presented studies of the economic impact of disease could be one way of promoting support for health sector projects among development planners and host country policymakers. Sector- and disease-specific studies could be very helpful in establishing and maintaining the priority of health care investments in increasingly cost-conscious political environments. A long-range goal (toward which this task is a tentative first step) is to develop methods usable by mid-level professionals in developing countries for carrying out economic impact studies as part of planning, resource allocation, and evaluation activities for health sector projects. Figure 1 presents a schematic placing the objective for this task in the larger view of economic analysis of water supply and sanitation projects.

Comprehensive analysis of the economic effect of water supply and sanitation interventions would have to include cost-analysis components, such as construction costs, costs related to community organization and participation, training, and ongoing operations and maintenance. Benefits analysis related to water supply and sanitation projects should include measurement of direct economic benefits, such as increased time availability when water is more conveniently located, commercial benefits (reflected in infrastructure improvement leading to increased investment and other opportunities), and health benefits, both *direct* in terms of avoided medical expenses and *indirect* in terms of productivity gains due to reduced morbidity. The focus of this report is only the health benefit aspects.

1.4 Approach of Task

Under this WASH task we examine methodologies for estimating health-related economic benefits in order to facilitate direct comparisons, both among and between health projects, as well as nonhealth projects, for the purpose of development planning at the national and regional levels. Estimating the economic benefits of health programs is important because health programs are not generally associated with economic benefits and thus are at a disadvantage when competing for funds with programs with more immediately obvious economic benefits. Our goal is to propose a workable and credible approach for valuing the economic effects of health programs in developing countries, based primarily on the COI model. To be a contribution, however, such a method must address and overcome earlier criticisms of the benefit-estimation approach.

We proceed below with an overview of the cost-of-illness approach and its limitations. This is followed by a model of the economic impact of health interventions in developing countries, which is intended to place our analysis in the larger context of policy decisions regarding health. In Section 2 we propose a methodology, consisting of outlines of a series of steps that must be completed, for designing COI studies, and discuss the implications of alternative assumptions. Finally, in Section 3 we discuss unresolved issues and make further recommendations. Appendix A provides a detailed review of selected health benefits studies

Figure 1

Task Orientation in Relation to Larger Economic Studies

Task Goal: Develop methodology for estimating the economic impact of avoided illnesses (related to II. C below)

ECONOMIC ANALYSIS OF WATER SUPPLY AND SANITATION INTERVENTIONS

I. Cost Analysis

- A. planning and design cost
- B. construction costs
- C. costs related to community participation
- D. training and support
- E. costs related to operations and maintenance

II. Benefit Analysis

- A. Direct economic benefits, e.g., increased time
- B. Commercial benefits, e.g., infrastructure
- **C. Health Benefits**
  - **— medical care expenses avoided ==> saved direct costs**
  - **— actual and potential productivity gains ==> saved indirect costs**

to illustrate the methodological and data problems associated with estimating economic benefits of health programs. Appendix B provides a series of table shells that illustrate the type of data needed and formats for presenting the data.

1.5 Overview and Limitations of Cost-of-Illness Methodology

The COI methodologies largely derive from human capital concepts. The COI approach to determining the costs of illness and disease has five components (Hodgson and Meiners 1979):

- Direct costs of medical resources used in treatment and/or prevention
- Indirect costs resulting from losses in economic output
- Other direct costs
- Social costs and quality of life reductions
- Overall cost increases throughout the economy

Direct costs of medical resources used include costs of diagnosis, treatment, ongoing care, rehabilitation, and terminal care, and they include costs to individuals and households for self-treatment, as well as costs to the government. Not included are the costs of research, facility construction, medical education, administration, and general public health programs that may have an impact on the disease.

Indirect costs resulting from losses in output occur as morbidity and mortality cause affected persons to lose time from work and household activity. The productivity loss is generally measured by the current value of lost earnings and the imputed value of lost household work. Additional adverse effects on productivity can also occur when the affected person is working, but at a less efficient level. Other indirect costs include time that patients spend visiting health care providers and time that family members lose from work while caring for a relative who is ill.

Other direct costs include transportation to health care providers, moving expenses, household costs to accommodate the needs of the affected person, and vocational, social, and family counseling services.

Social costs and quality of life reductions represent the pain and suffering associated with the disease. Any cost estimate that ignores the cost of pain and suffering will understate the true cost of the disease. To address the problem of how to quantify pain and suffering, health status indexes have been used to measure the utility loss associated with various health states, relative to some benchmark state (e.g., death).

Overall cost increases throughout the economy reflect the overall negative impact on gross national product due to reductions in productivity and redirection of resources for health care, which makes those resources unavailable for other uses.

The first two categories (direct and indirect costs) are referred to as the "core" costs of illness, and because of data limitations they often are the only two estimated, even in developed country studies (Cooper and Rice 1976; Rice et al. 1985). In leaving out the three other categories ("extensions to core costs"), all estimates of COI are thus conservative, lower bound estimates.

The feasibility of COI studies in developing countries relies to a large extent on identification of direct and proxy measures for the various costs. Data from sectors other than health have to be identified, accessed through the political and bureaucratic systems, and often modified or transformed before use. These tasks can require substantial creativity and resourcefulness on the part of the analyst.

Essential considerations regarding the data for these studies include (1) the reliability of the measures, (2) the ease with which they can be collected, (3) the cost of collecting them, and (4) the projected availability of the measures over time.

Essential concerns regarding the study methodology include (1) validity in the setting under study, (2) training and capabilities of the analysts who will apply the methodology, (3) the time and resources available to the analysts, and (4) the acceptability of the methodology to policymakers.

Even though the quantitative output from most COI studies is limited to core costs, estimates of extensions to core costs and the convincing presentation of those costs to promote awareness among policymakers and others are also a very important part of the strategy.

When the COI method is used to estimate the lost productivity for a person who dies prematurely, the lost productivity estimate is given as the stream of earnings that the person would have earned if he or she had not died. In reality, however, that is not necessarily the true loss that would have been experienced by society or even the household if the person died. It is instead a proxy measure for the value of the rest of the person's life. The loss that would be experienced by society is the difference between society's product, net of consumption, with the person well, and society's product, net of consumption, if the person dies. For an adult who dies, lost earnings net of consumption may be an overestimate of the true loss to society because, unless there is full employment and no substitutability of labor possible, a new employee can be hired and the productivity loss minimized. Productivity losses due to morbidity are greater than those due to mortality because of the continuing consumption of the sick person, although the losses are once again overestimated using the traditional COI method if there is unemployment or substitutability of labor. For a child who dies, the possibility of economic productivity from a "replacement child" should be considered in the calculation of society's economic losses.

To summarize, the standard COI approach may, in some cases, overestimate the economic effects of disease measured in terms of actual productivity gains. Viewing health as desirable in itself, however, policymakers may not wish to restrict consideration of benefits to only productivity because of society's view of the innate value or "standing" of members of society (Whittington and MacCrae 1986). The possible overstatement that may result from the traditional COI approach, therefore, could be considered to represent the increased value related to "standing."

1.6 Model of Economic Impact of Health Interventions in Developing Countries

Figures 2 and 3 provide a linked schematic for examining the relationship between improved health that might result from a development intervention, such as a water supply improvement, and improved economic well-being. As shown in the figures, the linkages are complex, and the existence of impacts, as well as their direction, is not well established. Although the focus of this task is near-term economic impacts ("core costs" of COI approach in Figure 3), it is important that the other linkages and effects be made specific so that the context for the COI estimates and the assumptions involved are completely clear. Additionally, any presentation of results regarding COI should be made in the larger context in order to familiarize policymakers with linkages, sequencing, and possible misestimation of true effects.

The discussion below briefly presents the overall model shown in Figures 2 and 3, linkages between elements, and possible methodologies for measuring linkages. Full discussion of linkages (outside those relating to the core elements of the COI approach) is beyond the scope of this task.

1.6.1 Health Benefits and Other Outcomes of Health Interventions

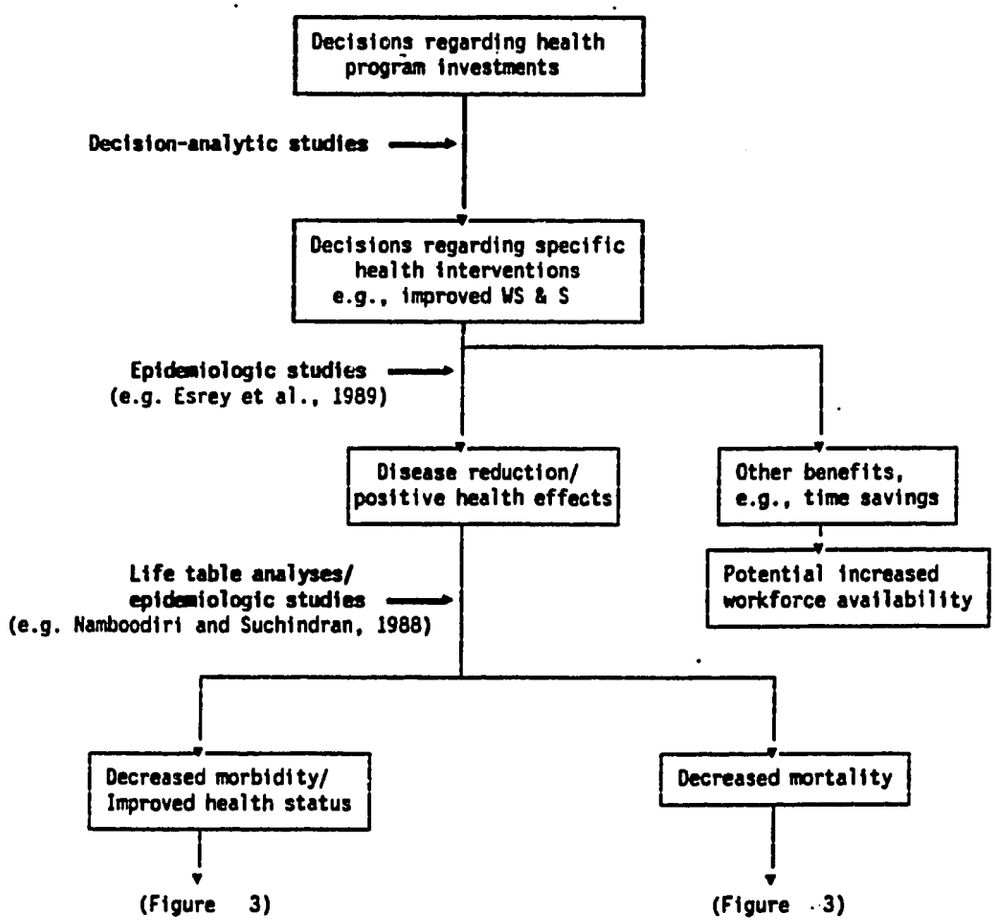
Initially, decisions must be made among alternative investments of scarce development funds. If health investments are to be made, decisions must be made about the specific health intervention (e.g., water supply and sanitation versus a categorical disease intervention program) and the specific configuration and implementation of that intervention (Figure 2). The ways these decisions can be made vary from the purely political to the highly empirical, the latter relying on good baseline epidemiologic data (Barnum 1987) and potentially utilizing sophisticated modeling techniques (Barnum et al. 1980) and decision-analytic techniques.

Assuming that a particular health intervention is implemented, the next linkage relates to estimating the level of disease reduction due to the health intervention. Such determinations rely on epidemiologic information and analysis. For the case of water supply and sanitation interventions, Esrey et al. (1990) reviewed and analyzed the findings from a number of disease-specific studies regarding the impact of the intervention. It should be noted, however, that broad-based interventions, such as improved water supply and sanitation, can have a favorable effect on a large number of diseases, as well as other direct economic effects, such as time savings offering the potential for increased productivity.

The impact of disease reduction on mortality can be estimated by the preparation and use of cause-specific life tables (e.g., Namboodiri and Suchindran 1988), the design and conduct of independent surveys and special studies, or the use of expert opinion. Modified applications of cause-specific life table analysis can provide data on the disease reduction—lowered morbidity (e.g., improved health status) link, but the data required for

Figure 2

Health Benefits and Other Outcomes of Health Interventions;
Types of Information Needed and Linkages



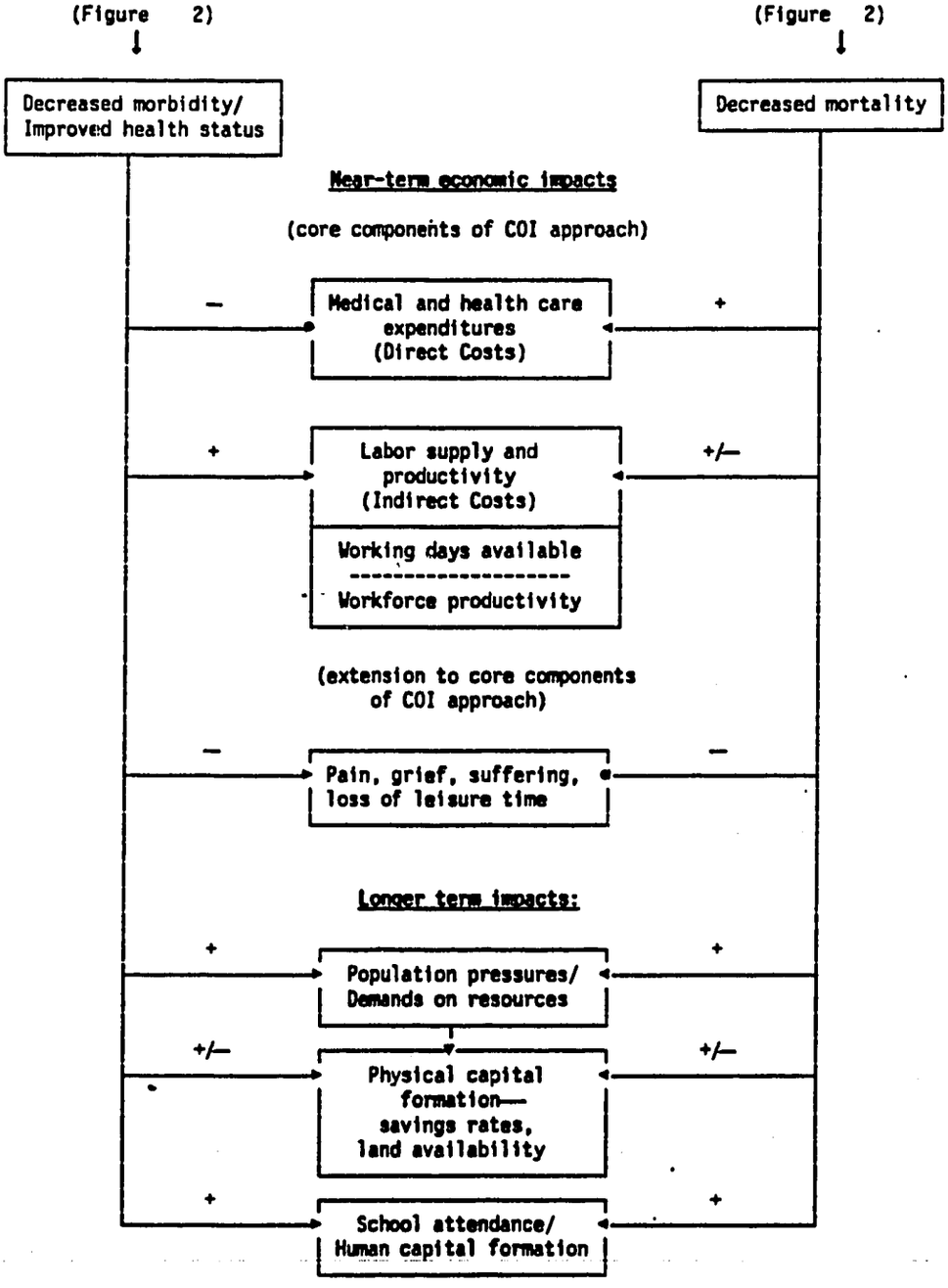
applications of life table analysis can be very difficult to obtain in developing countries. Epidemiologic data (which often are more available) can be used instead of life table data to estimate decreased morbidity and mortality.

1.6.2 Economic Effects of Reduced Morbidity and Mortality

The link between reduced mortality and morbidity for a disease and the near-term economic impact (Figure 3) is the focus of the COI methodology described above. Decreased morbidity

Figure 3

Economic Effects of Improved Morbidity and Mortality



Note: "–" = decrease is quantity indicated
"+" = increase in quantity indicated

can be expected to decrease the direct costs of illness, as reflected in medical and health care expenditures, and increase working days available and work force productivity. Decreased mortality, on the other hand, could result in higher direct costs if the lower mortality is associated with increases in long-term morbidity. Thus, lowered mortality may or may not have a favorable impact on the labor supply and productivity, depending on the attendant morbidity.

In the United States, the methodology for COI studies and examples of its application are well documented (Rice et al.; 1985, Salkever 1985). However, COI studies have methodological and data limitations when applied to developing country contexts. Table 1 presents some of the important methodological problems inherent in the COI approach for developing countries. Most critically, they include lack of data, relating to both costs and productivity, issues of foreign exchange costs, and measurement issues related to unemployment and substitutability of labor.

In addition to their near-term economic effects, decreased morbidity and mortality can be expected to lower the COI extension-to-core-costs of pain, suffering, and grief and thus increase the number of quality-adjusted life years.

The longer term impacts of decreased morbidity and mortality, however, will likely be mixed. Clearly, decreased mortality will increase population pressures and demand on resources. Lower morbidity will conceivably also increase demand on resources—through increased fertility, for example. Favorable long-term effects, however, include increased likelihood of physical capital formation because of increased returns for industrial development and increased human capital formation through improved school attendance. In the long run, reductions in disease incidence may also result in more land being available for development.

Table 1

COI Methodological Problems Related to
Core Economic Costs in Developing Countries

Direct costs of medical care:

- Lack of direct charge or cost data under national health systems or national health insurance programs. This would include data for both ambulatory (primary care) services as well as inpatient hospital care.
- Issue of foreign exchange costs for drugs or medical equipment that may have to be imported. In addition, accounting for costs of donated goods, such as oral rehydration salts, vaccines, or well-drilling equipment, is problematic and generally not addressed.

Indirect costs (loss of economic productivity):

- Valuation of productivity, particularly for household and nonwage labor in the rural sector, regarding both ill persons and their care givers.
- Issues of adjusting for labor substitutability, either as it relates to unemployment or substitution within the household.
- Issues related to age of ill person and subsequent productivity estimates; i.e., can full long-term economic productivity be assumed for children "saved" by a particular intervention?
- Issues of intervention effects on productivity other than health, e.g., time savings.

2

PROPOSED METHODOLOGY

2.1 Focus of Methodology

Our goal in this section is to describe a flexible and comprehensive methodology to guide program managers and policymakers in the design of COI studies and identification of data needs. The methodology is necessarily broad because the context for each study will be different. What is important is to design and produce a credible analysis, making sure the right questions are addressed and that all assumptions—and the implications of those assumptions—are made explicit. Sensitivity analyses for the different assumptions can then produce a range of plausible estimates. To the extent those estimates indicate robustness of the model, the policymaker/program manager can be confident in the results; otherwise, more investigation may be necessary.

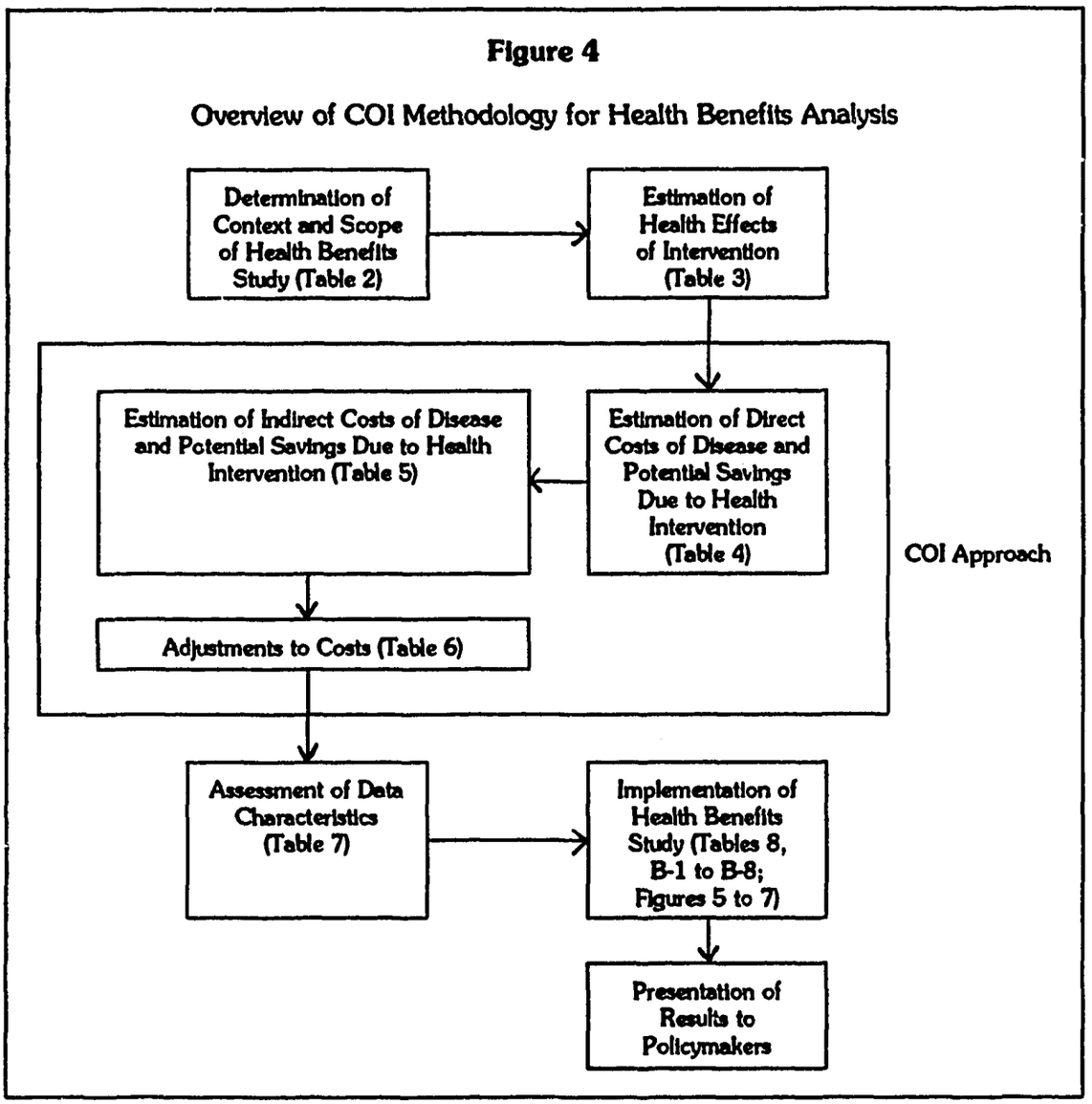
As noted in Section 1, COI studies (and the focus of this methodology) are concerned with the near-term economic impact of a disease and possible gains from its control. Before such COI assessments can be made, however, it is first necessary to understand the larger context of the COI assessment, which may then guide the type of analyses to be employed. Second, information on the epidemiology and other characteristics of the disease must be obtained and integrated into the analysis. Disease-specific information will critically affect the factors to be considered and the approach of the analysis. Third, implementation of the COI approach itself requires consideration of a number of factors and assumptions. Finally, data issues must be considered at all points in the design and implementation of the study. It is unlikely that the necessary resources will be available to fund extensive new data collection efforts. Adequate consideration of data issues, therefore, will likely result in modification of the design and, perhaps, even the goals and objectives of the study.

2.2 Approach

This subsection discusses the issues noted above, and illustrated in Figure 4, and presents a sequence of suggested steps that constitute an approach for the conduct of COI studies in developing countries. The approach must be multidisciplinary. In particular, it requires the application of epidemiologic analysis and information gathering to determine the linkages between health programs and different levels of severity of the disease and disability or mortality in the affected populations. Economic analysis and information gathering are also necessary to determine the linkages among health status, use of health care resources, and productivity.

Figure 4

Overview of COI Methodology for Health Benefits Analysis



2.2.1 Determine Context/Scope of the Study

It is first necessary to define the context and scope of the analysis needed to satisfy the goals of the policymaker. Table 2 identifies some of the initial broad policy questions (discussed below) that must be addressed before the context and scope of the analysis can be determined.

Table 2

Determining Context and Scope of the Study

1. Determine what the results are needed for:
   - intersectoral planning
   - health sector planning
   - program evaluation
2. Determine at what level the results are needed:
   - national
   - regional
   - local
3. Determine the time frame over which economic impacts should be estimated:
   - near term
   - long term
4. Determine the desired scope of the analysis:
   - cost-benefit, cost-effectiveness, or implementation costs alone
   - level of aggregation, e.g., national, regional, local
   - time period for consideration

Determine what the results are needed for.

Intersectoral planning implies comparisons between health program alternatives and other development programs, such as in the area of education or housing. Measuring "external efficiency" (Prescott 1989) requires the use of cost-benefit analysis and the difficult conversion of benefits and costs of each project to a single monetary scale.

Health sector planning uses include (1) deciding between health program alternatives with the same goal, for example, health education versus chemical treatment for the control of a parasite responsible for a disease, for which cost-effectiveness analysis may be appropriate,

and (2) deciding between health programs with differing goals, for example, an immunization program for measles versus an oral rehydration program for diarrhea. For this latter case, cost-effectiveness analysis may be possible with the use of a common outcome metric, such as healthy days of life gained. Alternatively, cost-benefit analysis, with all costs and benefits converted to monetary units, might be used.

Program evaluations usually (but not necessarily) focus on assessing direct costs related to the intervention program; they often omit indirect costs, long-term costs, or comparisons with alternatives. Program cost studies would be sufficient for program evaluation, and they are substantially more straightforward than the analysis needed for comparative purposes, either are internal or external to the health sector.

Determine at what level the results are needed.

This step is important for defining the scope of the study and determining the potential data needs and potential usefulness or impact of the study. Questions to be asked include, Is the interest more global, that is, for the purposes of national-level planning? Or is the focus more on regional or local planning needs?

Clearly, the scope of the study and the data needs are very different if national rather than local or regional results are needed. National estimates can be generated as the sum of the local or regional impacts estimated using regional or local data. However, the availability (or reliability and comparability) of local data may make this approach difficult. Alternatively, national estimates may be generated from national-level data, which are more accessible but which may restrict the usefulness of the results at the regional/local level.

A related issue is knowledge regarding decision points, that is, the level at which decisions are made. If all decisions are centralized, a study conducted by regional- or district-level authorities may have little policy impact. If, on the other hand, decision making has been decentralized, conduct of the study at the lowest level of decision-making autonomy should improve the focus and potential usefulness of the results.

Determine the time frame over which the economic impacts should be estimated.

The scope of the study and data needs also depend on the time frame of importance to the decision maker. This time frame may depend on the expected effects of the health program. For example, if the health program is expected to have a relatively small impact on the affected population, estimates of the short-term effects might be sufficient to capture completely the effects of the health program. On the other hand, if the health program is expected to have large effects, especially on death rates and fertility rates, estimates of both short- and long-term effects might be necessary to capture the effects of the health program completely.

Determine the desired scope of the analysis.

Once it has been established how the results of the analysis of the health intervention will be used, and whether there are long-term effects as well as short-term effects to be determined, the desired scope of the analysis can be established. Determining the scope of the analysis requires decisions about whether to perform a cost-benefit analysis, cost-effectiveness analysis, or a simple comparison of program implementation costs; the level of aggregation of the analysis; and the time period for the analysis. Whether an analysis with the desired scope can be performed will depend critically on the availability of data for estimating the benefits or effectiveness of the health intervention. Often, the desired scope will have to be modified because of data limitations. Before describing potential data limitations, we describe a series of steps designed to estimate the benefits or effectiveness of a health intervention, which will clarify data needs.

2.2.2 Estimate Effects on Health of the Proposed Intervention

To estimate the effects on health of the proposed health intervention, we propose a series of steps to identify the disease type (acute, chronic, acute/recurring) and estimate disease incidence and prevalence, effects on mortality and morbidity, and possible differential distribution of disease effects across the affected population. Table 3 lists the steps, along with some examples of estimation methods.

Identify the type of disease being targeted.

The critical aspects to consider regarding disease type (acute, chronic, acute/recurring) relate to the interaction of the disease with the mode of economic productivity. For an acute disease, such as guinea worm infection, the worker may be entirely nonproductive for short periods of time. Without substitution for the disabled worker or adjustment of the production system (e.g., substitution of alternative crops), this effect may have serious implications for production that has specific time requirements, such as transplanting rice (Audibert 1986). Chronic diseases, such as schistosomiasis, offer a greater opportunity for long-term adjustments to compensate for lowered capability, which may partially account for the difficulties in demonstrating the impact of malaria and schistosomiasis on productivity (Conly 1976; Weisbrod et al. 1973). Additionally, the acute/recurring nature of a disease like malaria is such that the recurrences may not coincide with critical production periods and, therefore, may not have a substantial impact on output when the attacks are relatively infrequent (Audibert 1986).

Estimate how the population of interest is currently affected by the disease.

The first set of data that are essential to estimating the health benefits from a disease reduction program are current disease incidence and disease prevalence rates for the

Table 3

Estimating the Health Effects of the Intervention Program

1. Identify the type of disease(s) being targeted:
   - acute (e.g., diarrheal disease)
   - chronic (e.g., schistosomiasis)
   - acute/recurring (e.g., malaria, guinea worm)
2. Estimate how the population of interest is currently affected by the disease(s) of interest:
   - sex- and age-specific incidence rates
   - sex- and age-specific prevalence rates
   - seasonal patterns of the disease
   - proportion of cases at different levels of severity (e.g., mild, moderate, severe)
   - mortality rate associated with each level of severity of disease for each sex and age group
3. Determine how other diseases and nutritional status in the population might interact with the disease(s) of interest.
4. Specify for the population of interest the expected impact of the health intervention on the disease(s) of interest, at different levels of severity.
5. Estimate the number of days/years of healthy life that will be gained due to the intervention taking into account the interactive effects with other diseases and nutritional status:
   - estimate gains due to reduced mortality for different sex and age groups, computed as difference between average age at death with the disease and expected remaining life expectancy at that age
   - estimate gains due to reduced amounts and degrees of temporary disability for different sex and age groups at different seasons, computed as average period of each degree of temporary disability for those who do not die from the disease, multiplied by the proportion of disablement
   - estimate gains due to reduced amounts and degrees of permanent disability for different sex and age groups, computed as expected remaining life expectancy from age at disability, multiplied by the proportion of disablement
6. As appropriate for the analysis plan, estimate the long-term effects of the health intervention:
   - estimate changes in age-specific mortality rates for the population
   - estimate changes in age-specific fertility rates for the population
   - estimate changes in size and age distribution of the population over the time horizon of interest from estimates of the mortality and fertility changes

population of interest. National data may be inappropriate for certain local areas if disease incidence is not uniform throughout the country. If local or regional data are not available, expert judgment may be used to modify the national estimates for the population of interest. It is also important to have estimates of disease incidence and prevalence by sex and age

cohorts because the use of medical care and productivity losses attributable to the disease may vary by age and sex.

In addition, it is important to obtain estimates of the proportion of cases in the population at different levels of severity and for different seasons. For example, mild cases of schistosomiasis should be distinguished from moderate and serious cases because of the great differences in the effects on the individual. More important, two populations could have the same incidence of a disease but very different proportions of mild cases. The economic benefits from reducing the incidence of the disease in the two populations, therefore, could be very different. Finally, seasonality of disease symptoms can be important in affected areas where productivity varies from one time of year to another.

Determine the impact of other diseases and nutritional status.

It is important to have some information on other diseases that affect the population of interest as well as information on nutritional status. Both factors are interrelated with the current incidence, severity, and prevalence of the disease of interest. They also influence the effects of any health care intervention targeted at the disease of interest. The positive effects of some types of interventions may be offset by the presence of other diseases and poor nutritional status. On the other hand, some types of interventions, such as improved water supply, may have effects on multiple diseases and those effects may reinforce each other in a positive manner.

Estimate the expected impact of the health intervention.

The analysis must address the expected impact of the intervention on levels of disease incidence, prevalence, severity (in the case of morbidity), and mortality. If complete data are not available, expert judgment should be used to derive estimates for missing parameters. Sensitivity analysis should be performed on those parameters since the impact of the health program on economic productivity can be expected to vary in accordance with differential impacts on these disease factors. For example, severe cases of a disease may have a strong negative effect on productivity, but mild cases may have very little. In this instance, an intervention that selectively reduces the number of severe cases, without necessarily lowering the actual incidence or prevalence of the disease, may result in as positive an economic effect as an intervention that more directly addresses reducing incidence without affecting the distribution of disease severity.

Estimate the number of days of healthy life that will be gained.

Estimated changes in disease incidence and severity should be translated into estimated changes in days of healthy life. It is first necessary to estimate the losses in days of healthy life associated with each level of severity of the disease in the population. The losses in healthy days should be estimated separately for each age group, sex, and season because

losses in productivity will vary according to these factors. In addition, the losses in healthy days should be subdivided into different levels of disability caused by the disease.

National estimates of such losses have been derived for many diseases in Ghana (Ghana Health Project Assessment Team 1981). The losses were subdivided into losses from mortality, morbidity, and debility. However, they were not estimated separately for different levels of severity of disease or for different ages, sex, or seasons. Because they represent the weighted average of disease severity in Ghana, the losses may not necessarily be applicable in other countries, where the distribution of disease severity may be different. Thus, expert judgment or primary data collection may be necessary to derive these estimates for the specific population of interest. In addition to disease severity, other diseases and the nutritional status of the population of interest will affect the gains in healthy days from changes in the disease of interest.

Estimate the long-term health effects of the health intervention.

When a long-term analysis is attempted, long-term health effects of the intervention must be estimated. These long-term effects include the gains in days of healthy life over the lifetime of those currently living, but they also include the increased days of healthy life for children as yet unborn. If the health intervention increases the number of fertile women and fertility rates, in the long run the population may increase, depending on offsetting reductions in the need to replace children who die or who are expected to die.

2.2.3 Estimate the Economic Impact of Disease: COI Issues

In assessing the economic impact of the disease, steps specific to the COI methodology must be completed after the health effects of the health program have been estimated. The steps yield estimates of the direct and indirect costs avoided as a result of the health program.

2.2.3.1 Direct costs

The direct costs of a disease are defined as the costs of the medical care resources needed to treat the disease. The costs of treating the disease both with and without the health program depend on several factors, including level of access to treatment and treatment needs for each level of disease severity. The steps necessary for estimating the avoided direct costs of a disease attributable to the health program are shown in Table 4 and are discussed below.

Table 4

Estimating the Direct Costs in the Cost-of-Illness Approach

1. Estimate the proportion of those affected at each level of severity of the disease (i.e., mild, moderate, severe) who desire treatment.

2. Estimate the proportion of those desiring treatment who have access to treatment facilities currently, and who will have access in the near future, if different.

3. Specify the process of treatment for each level of severity of the disease (i.e., mild, moderate, severe):

   - number of hospital days, if any
     - hours of health care labor with different levels of training (e.g., MD, RN, Aide)
     - drugs (imported or domestic)
     - hospital supplies (e.g., IV solutions, bandages, etc., imported or domestic)
     - use of equipment (e.g., X-ray, operating room tables and instruments, etc., imported or domestic)
     - facilities (e.g., regular bed, intensive care bed, food service)

   - initial outpatient visits and number of follow-up outpatient visits related to or independent of hospital stays
     - hours of health care labor with different levels of training (e.g., MD, RN, Aide)
     - drugs (imported or domestic)
     - supplies (e.g., bandages, crutches)
     - use of equipment (e.g., X-ray, lab)
     - facilities (e.g., examining rooms)

4. Estimate the unit costs of resources used for treatment and the side effects for each level of severity of the disease:

   - unit costs for labor (wage rates or shadow prices of labor, i.e., value of time in alternative uses)

   - unit costs for drugs (cost of drugs or shadow prices of drugs with costs weighted upward for imported drugs, depending on the scarcity of foreign exchange)

   - unit costs for supplies (cost of supplies or shadow prices of supplies with costs weighted upward for imported supplies, depending on the scarcity of foreign exchange)

(continued)

Table 4 (continued)

5. Estimate the total costs of treatment for each level of severity of the disease without the health intervention:
   - unit costs multiplied by resource use for a typical case at each level of severity
   - cost per case at each level of severity multiplied by the number of cases at that level of severity that receive treatment in a given time period before the health intervention
6. Determine the proportion of costs that can be avoided in the short and long run:
   - variable costs can be avoided immediately (e.g., drugs and supplies)
   - "semi-fixed" costs can be avoided after a short delay (e.g., labor)
   - fixed costs can be avoided in the long run (e.g., facilities and equipment)
7. Determine the direct costs that would be avoided as a result of the health intervention:
   - multiply estimated cases avoided at each level of severity by the proportion of those receiving treatment and by the typical treatment costs
   - compute the costs avoided at all levels of severity
   - calculate the costs that would be avoided immediately, in the short run, and in the long run

Estimate the proportion of those affected at each level of severity who seek treatment.

The need for and decision to seek care vary according to the severity of the disease. The direct cost savings from avoided treatment thus depend on the current distribution of disease severity and the expected effect of the health program on that distribution.

Estimate the level of access to care for the disease.

Savings in treatment costs depend on the current availability of treatment and on the ease of access to treatment for people with the disease. If a large percentage of people needing and desiring treatment are not currently receiving it, then savings in treatment costs from reducing disease incidence will be less than if all persons needing and desiring treatment have access to appropriate facilities. Further, if there is current unmet need, it is also important to determine whether there are any plans in the short run to meet that need.

Determine the process of treatment at each level of severity.

The process of treatment varies according to the severity of the disease. Treatment may include hospitalization, outpatient visits, and drugs and other supplies. The level of training required for the involved health care professionals also varies according to the disease and its level of severity.

Estimate the unit costs of resources used at each level of severity.

The total costs of treatment at each level of disease severity depend on the resources used and the unit costs of those resources. The need for drugs or other supplies that have to be purchased abroad, and therefore with scarce foreign currency, has implications for the balance of payments. These effects must also be included in the unit costs of medical resources. The opportunity cost of the labor used to treat patients is an additional key determinant of the unit costs of treatment. If there are few alternative uses for the time of the health care workers, their opportunity cost is lower than if there are many alternative uses for their time.

Estimate the total costs of treatment for each level of severity.

To estimate the total costs of treatment at each level of severity, the resources used for treating a typical case at each level of severity are multiplied by the unit cost for those resources. The total costs for treatment of a typical case at each level of severity are then multiplied by the number of cases at that level of severity currently receiving treatment (or anticipated to receive treatment in the near future).

Determine which costs can be avoided in the short and long run.

The total cost of treatment at each level of severity must be broken down into fixed and variable costs, depending on the ease of avoiding those costs if treatment is no longer required. Clearly, drugs and supplies no longer needed reduce costs immediately. Reduction in the need for staff and facilities may reduce costs only after a time lag because commitments may have been made to employ those resources for a given time period. In addition, facilities may also be used for treatment of other diseases, and it may not be possible, in either the short or long term, to reduce the size of the facility when demand for health care is reduced for a particular condition.

Estimate the direct costs that would be avoided as a result of the health intervention.

Once the costs of treating different levels of severity of the disease have been estimated, the total costs avoided are estimated by multiplying those costs by the number of cases avoided at each level of severity and the proportion of those cases receiving treatment (or anticipated

to receive treatment in the near future). The costs avoided can also be estimated separately for the short and long run.

2.2.3.2 Indirect costs

The indirect costs of a disease are defined as the reduction in productivity experienced as a result of the disease. Productivity measures may be restricted to marketable goods or may also include goods produced for home consumption only. The indirect costs of the disease both with and without the health program depend on several factors, including the type and characteristics of the economy, the community and family structure, and the desired measures of productivity. The steps necessary for estimating the avoided indirect costs of a disease are shown in Table 5 and discussed below.

Specify the type of economy.

The economy (whether national, regional, or local) must be described in terms of several factors: market versus nonmarket, cash versus noncash, agricultural versus nonagricultural, subsistence only, and so on. The more local the level of analysis, the more homogeneous the type of economy, and the easier it will be to describe the economy accurately. The type of economy has important implications regarding assumptions of productivity loss due to the disease under consideration.

Specify the characteristics of the economy.

The economy should also be described in terms of (1) levels of unemployment and underemployment; (2) capital availability, in order to gauge the potential of the economy to absorb greater numbers of healthy workers; and (3) considerations of potential substitutability of labor or crops. For example, communities attempt to mitigate the effects of endemic disease in many ways, including (1) substituting labor among family or community members, (2) the planting of possibly less profitable but less labor intensive crops, and (3) altering planting schedules for crops. All of these actions are undertaken to reduce, to the extent possible, the productivity losses associated with disease. The ability to substitute labor or crops varies according to the type and characteristics of the economy and the geographic region. For example, unskilled labor, especially agricultural labor, is more easily substituted for by family members than skilled labor.

Specify the characteristics of family and community structure.

The economic effects of the disease are also influenced by the family and community structure. Allocation of time by both healthy families and families faced with sickness provides insights into the availability of substitute labor, which could mitigate adverse economic effects of disease in either a market or agricultural economy. Allocation of time within the family also provides measures of other household production, such as human capital development.

Table 5

Estimating the Indirect Costs in the Cost-of-Illness Approach

1. Specify the type of economy for the population of interest:
   - market or nonmarket
   - cash or noncash
   - agricultural or nonagricultural
   - home or outside the home
   - mixed (specify proportions of each characteristic)
2. Specify the characteristics of the economy for the population of interest:
   - unemployment and underemployment rates by age, sex, and skill level
   - availability of new capital for increased production
   - substitutability of labor by age, sex, and skill level
   - substitutability of crops and planting schedules
3. Specify the family and community structure:
   - family structure and allocation of time within family
   - community structure and migration patterns
4. Specify the unit of analysis:
   - individual
   - household
   - community
5. Specify the desired measures for productivity changes:
   - changes in production of market goods (e.g., agricultural products, consumer goods and services) for the population of interest
     - sum of individual changes
     - sum of household changes
   - changes in production of nonmarket goods (e.g., human capital development, child care, leisure) for the population of interest
   - changes in all production for the population of interest
     - sum of individual changes
     - sum of household changes

(continued)

Table 5 (continued)

6. Estimate the maximum gain in productive time as a result of the health intervention:
   - days of healthy time gained as a result of the health intervention for the disease sufferer by age, sex, and season
   - days of time gained for care giver (time not needed for care of sick patient) by age, sex, and season

7. Estimate the maximum value of gain in productive time:
   - estimate per capita daily value of production of market goods in the region by sex, age, and season
     - quantity of each market good produced
     - selling price per unit
   - estimate per capita daily value of production of nonmarket goods in the region by sex, age, and season
     - quantity of each nonmarket good produced
     - estimated value per unit
   - combine estimates of per capita values of productive time with estimates of the gain in productive time attributable to the health intervention

In- and outmigration opportunities, along with employment-level information, reflect the availability of substitute labor in the community.

Specify the unit of analysis.

There are at least three possible units of analysis: the individual, the household, and the community. The choice of the unit of analysis depends on the planned use of the analysis as well as on available data. For example, a household analysis may give the most realistic picture of the effect of the health program on community welfare. However, if there are no data on the substitutability of labor within the household, such an analysis may be infeasible. If analysis at the household level is not possible, then analysis at the individual level becomes the default. Community-level analysis is the sum of either household or individual analyses.

Specify the measures of productivity changes.

Productivity changes can be measured as changes in cash production only or changes in noncash production, including both agricultural products and other home-produced commodities (e.g., education). The most comprehensive measure would include all these changes. However, data limitations may make that infeasible. If the economy is largely a cash economy, then a measure of the changes in cash production is probably sufficient. On the

other hand, if the noncash economy is important, it should not be excluded from estimates of the potential benefits.

Estimate the maximum gain in productive time from the health intervention.

The analysis of the effects of the disease on health and the effects of the health intervention on the disease results in estimates of the healthy time gained as a result of the health intervention. Those estimates determine the upper bound for the gain in productive time for both the disease sufferer and the care giver, the latter in terms of time not needed for care of the sick person. To be useful for productivity estimates, the healthy time gained as a result of the health intervention should be subdivided by age, sex, season, and level of disability avoided.

Estimate the maximum value of the gain in productive time.

The maximum value of the gain in productive time is equal to the per capita daily value of production multiplied by the number of days gained attributable to the health intervention. For market-traded goods, the selling price per unit is a good estimate of the unit value. Per capita daily output for a product can be approximated by dividing a total community output measure by the number of people available for production (in the labor force). Differentiating output levels among age/sex groups may be difficult. For goods that are not market traded, all these estimates are likely to be difficult to generate. For this reason, the scope of the analysis may have to be restricted to changes in productivity for market-traded goods.

Adjust the estimates of the maximum value of productivity gains.

The maximum value of productivity gains may overestimate actual productivity effects for several reasons, including community unemployment, availability of new capital, and substitutability of labor. Because it is not possible to determine the magnitude of these effects with any precision, we propose a set of "rule-of-thumb" adjustments that will increase the credibility of the results of the analysis. These adjustments are described in Table 6. Where indicated in the table that per capita production will rise or fall, expert judgment for the specific community can be used to estimate the magnitude of the effect.

Estimate the long-run productivity effects.

If a long-run analysis is needed, some attempt must be made to estimate how per capita production will evolve over time as a result of the health intervention. Over the long run, per capita production depends on population growth and the growth or decline of capital available for production. The only attempt in the literature to perform a long-term analysis used a simulation approach that required large amounts of data and a complex structural model. If long-term estimates are required, a more focused approach may be appropriate,

Table 6

Adjustments to COI Approach

1. Adjust the estimates of the maximum value of productive time according to economy type and characteristics:

   - unemployment rates in different seasons for market and nonmarket goods
     - — for conditions of excess demand for labor, assume that all additional labor is fully productive at the current per capita output
     - — for conditions of full employment, assume that all additional healthy time is fully productive at the current per capita output
     - — for low levels of unemployment/underemployment and small changes in disease effects, assume that unemployment/underemployment rates remain unchanged and thus per capita production remains unchanged
     - — for low levels of unemployment/underemployment and large changes in disease effects, assume lower per capita production levels for the gained healthy days
     - — for high levels of unemployment/underemployment, assume no change in production associated with the disease effects
   - availability of new capital for market or nonmarket production
     - — if no new capital is available, the disease effects are large, and there is not an excess demand for labor, assume that per capita production declines
     - — if new capital is available, assume that per capita production remains unchanged even when disease effects are large
   - substitutability of labor
     - — if labor for the production of market goods can easily be substituted and employment is less than full, assume that production of market goods will not be increased by health intervention but production of nonmarket goods will be increased
     - — if labor for the production of market goods cannot easily be substituted, assume that production of market goods may increase with the health intervention, depending on the unemployment effects

2. Estimate the productivity effects:

   - estimate short-run and long-run per capita production incorporating changes in the population and information on the availability of new capital for production of market and nonmarket goods

with per capita production estimates over time dependent on an assumed rate of population change and new capital formation. These assumed rates of change would be based on best estimates of the population effects of the health intervention and expert opinion about the possible growth or decline in available capital. Sensitivity analysis would then be necessary to show how changes in the estimates would change the results.

2.2.4 Assess Data Considerations

Data issues relate directly to data availability, data quality, level of disaggregation of the data, compatibility/comparability with other data sources, and costs and difficulties of new data collection efforts. Although these issues may sound formidable in the context of developing countries, data availability and quality are improving rapidly in many developing countries. As mentioned earlier, the issue may not be as much one of instituting new data collection systems as it is one of creative validation, combination, and utilization of existing sources.

The availability of data (or of resources to collect data) is of critical importance to the feasibility of cost-effectiveness or cost-benefit studies. Thus, it is important to understand data constraints before choosing a method to estimate the economic effects of health interventions.

Data likely to be available on an ongoing basis for the national and, perhaps, regional levels in most developing countries include the following:

- Demographic statistics, such as birth rates, death rates, and disease incidence rates
- Epidemiologic data, such as disease mortality, debility, and morbidity rates
- Aggregate medical care costs, such as the cost of treating a case of the disease
- Economic data, such as gross domestic product and employment rates

These same data are less likely to be available at the local level unless gathered during previous special studies or surveys. Data that are likely to present problems at all levels (national, regional, local) include measures of individual or household market and nonmarket productivity, measures of individual or household health status, and measures of school attendance.

Table 7 presents a summary of the characteristics of data sources that might be used for the analysis of the economic impact of health programs. The various characteristics contribute to the costs and completeness of the available data and help to determine the validity of the results of the study. Each of the characterisitcs is discussed briefly below.

Table 7

Critical Characteristics of Data

1. Data types:
   - administrative, ongoing
   - surveys, ongoing
   - surveys, one time
2. Data sources:
   - government
   - private
   - confidentiality/release requirements
3. Relevance of the data for population of interest:
   - precision/focus/appropriateness
   - timeliness
4. Critical characteristics regarding the collection of survey data:
   - sample design
   - sample sizes
   - stratification variables
     - — data collection methodology
   - one-time, cross-sectional
     - — multiple cross-sectional data collection
     - — longitudinal, panel design
   - reliability, validity
   - response rate
5. Frequency of data collection (e.g., periodicity):
   - plans for subsequent data collection
   - modifiability of future data collection effort

(continued)

Table 7 (continued)

6. Level of disaggregation possible:
   - geographic (e.g., regional, district, etc.)
   - population characteristics (e.g., age/sex)
   - geographic subgroups
   - population subgroups
7. Data acquisition and processing costs:
   - acquisition
   - processing
   - storage

Data types and sources.

The source of the data, government or private, determines both the cost and ease of acquiring the data, as well as the credibility of the numbers. For example, private data might be harder to obtain and to use, and it might be difficult to release the results if the data include confidential information. Administrative data from the government, or government-sponsored surveys, might, however, be easier to obtain for official studies.

Relevance for the population of interest.

The available data may have been collected for a different purpose and, thus, the precision or focus may not be quite what is needed for the analysis. If this is the case, the data may still be usable if modified. Any such modification should be undertaken by an expert familiar with the original data collection process and the use of the data in the proposed analysis. In addition, the available data may have been collected several years previously; appropriate modification to account for changes over time (e.g., cost inflation) would be necessary in this case.

Critical characteristics of the collection of the data.

The validity of the results of the study depend critically on the data used. Thus, it is important to examine the statistical validity of the data for the population of interest. Such data should be collected with adequate sample sizes and using reasonable stratification variables. The data

collection methodology should be appropriate for the use of the data in the analysis, and the response rate should be high with regard to survey data.

Frequency of data collection.

For data that are collected repeatedly, it might be possible for the analyst to modify the collection instrument to include additional data that are needed for the study. If a new round of data collection is to be undertaken, adding a few questions to an ongoing effort could result in new data collection at a low incremental cost.

Level of disaggregation.

The level of disaggregation for available data, both geographic and demographic, may not be sufficient for the desired analysis. In this case, expert judgment can be used to adapt the aggregated data to different geographic or population subgroups.

Direct costs related to data.

Acquisition and processing of available data and new data collection are often the largest expenses in performing an economic analysis of a health intervention. Actual data analysis usually requires only modest expenditures.

2.3 Implementation

In order to implement the health benefits analysis for specific health programs using the COI approach, the analyst must decide on the scope of the study, collect the needed data, and perform the calculations. Table 8 presents a guide to the choice of scope for the study. Eight tables presented in Appendix B are blank table shells designed to illustrate the types and formats of data that should be collected in order to operationalize the model just described. Data in the format illustrated in these table shells could be used as the input data for a computerized spreadsheet model designed to perform the health benefits calculations. Such a computerized model could be fairly simple but would have to be tailored to the local context and needs of each particular analytic scenario. Some general examples of the types of calculations that should be performed are given in Figures 5 through 7.

The economic benefits from disease control for a region depend on many local factors, including type of economy, level of employment, nutritional status of population, water supply and sanitation facilities, number of endemic diseases, household structure, and political and legal constraints. Given the multidisciplinary nature of the issues, the appropriate person or team to perform such studies will have a broad understanding of the realities of life in the region and will be in a position to be creative in obtaining data needed for the analysis. These data may be available from national or regional data collection efforts or may require

primary data collection, such as community surveys or polling of local experts. Primary data collection efforts almost always involve seeking out funding sources or collaborating with multiple institutions. Brieger and Guyer (1990) describe the efficient use of medical students in Nigeria to conduct a new household survey of farmers to gauge productivity loss due to guinea worm.

With regard to analyses at higher levels of aggregation, a national health or development planning organization may want to compare the impact of several alternative health programs on the national or regional economy. In such cases, the conduct of the studies should be centralized so that the methodology and assumptions are consistent among them. However, centrally conducted studies must work closely with local planners and information resources to gather the data needed for the analysis and to develop the appropriate methodology. Input by persons familiar with specific characteristics of the region or local area is essential to prevent estimates of economic benefits that have no basis in the reality of the local situation.

Table 8

Determining Scope of Study

Scope of Study	Type of Analysis Needed			Data Needed at the Chosen Level of Analysis			
	Cost/ Benefit(a)	Cost-Effectiveness(b)	Cost Only	Treatment Costs and Rates	Health Effects	Short-Term Production Effects	Long-Term Population and Capital Formation Effects
1. Intersectoral planning—short term	✓			✓	✓	✓	
2. Health sector planning—short term	✓	or ✓		✓	✓	✓(a) only	
3. Program evaluation—short term	✓	or ✓	or ✓	✓	✓(a), (b) only	✓(a) only	
4. Intersectoral planning—long term	✓			✓	✓	✓	✓
5. Health sector planning—long term	✓	or ✓		✓	✓	✓(a) only	✓
6. Program evaluation—long term	✓	or ✓	or ✓	✓	✓(a), (b) only	✓(a) only	✓

Figure 5

Computation of Days of Healthy Life Gained
in Short-Term Study, by Age Group and Sex

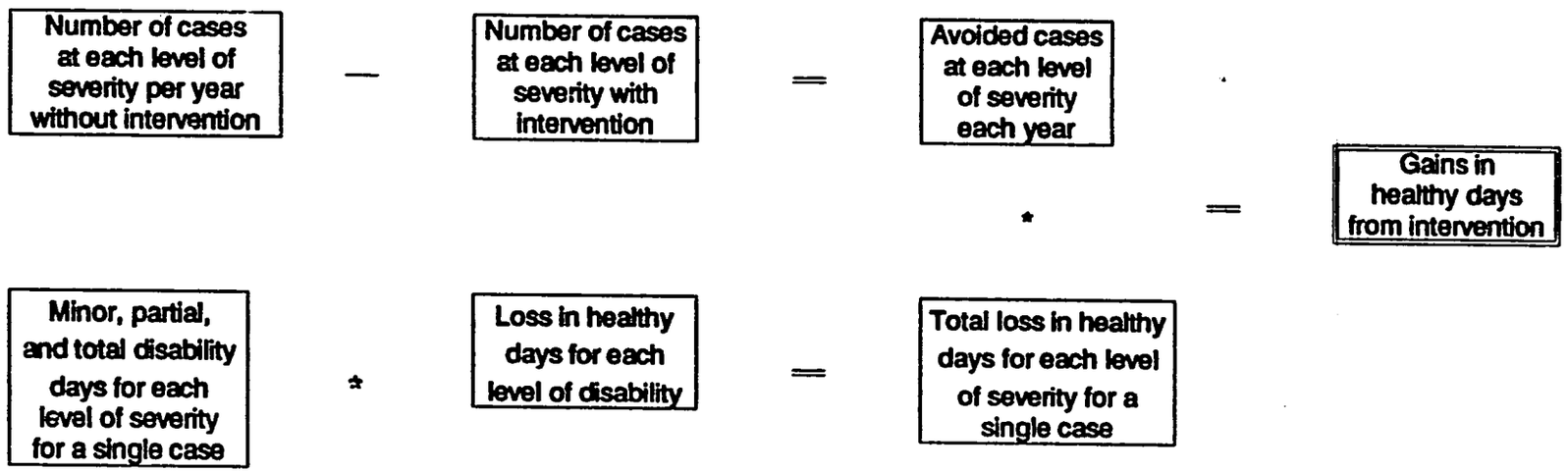


Figure 6

Computation of Avoided Direct Costs

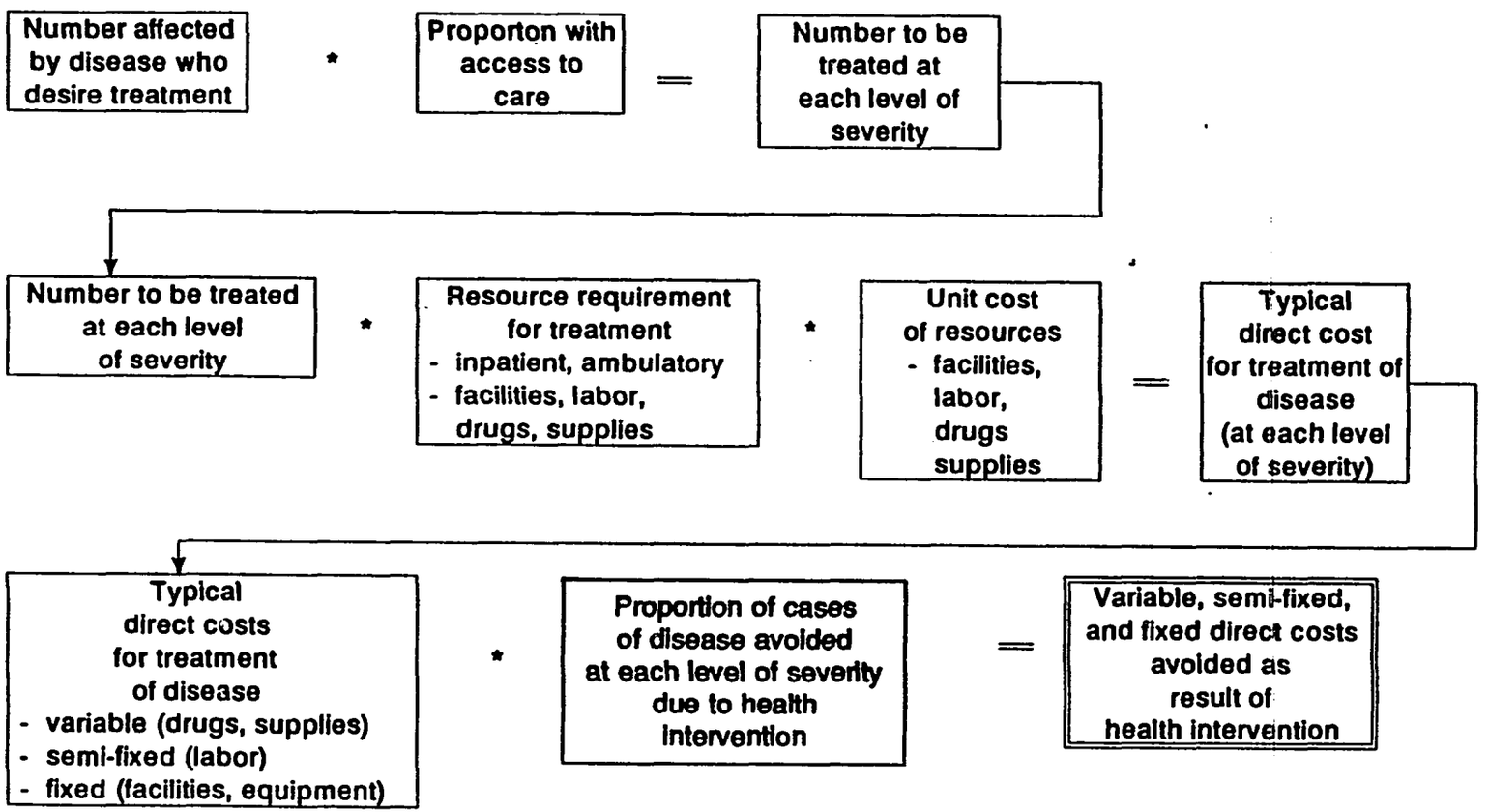
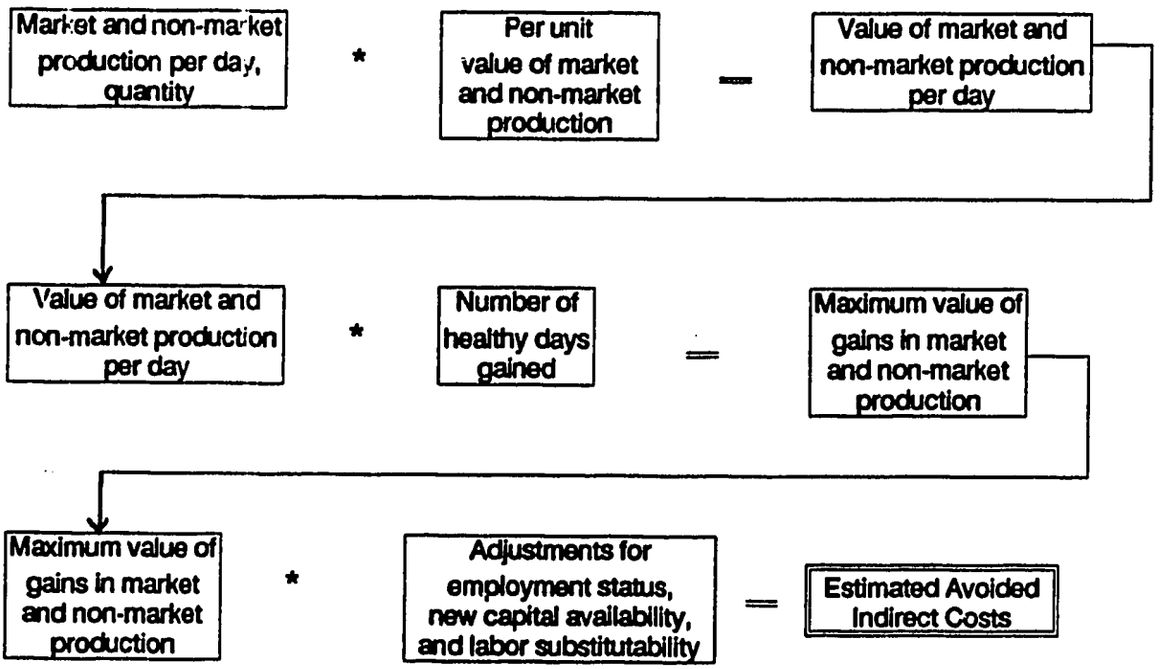


Figure 7

Computation of Avoided Indirect Costs
(Market and Nonmarket Productivity Losses),
by Age Group and Sex or by Household



2.4 Presenting the Results

We have described above and in Appendix A the methodological and data issues associated with estimating the economic benefits of a health program. The question we now address is how should the results be presented.

The level of precision required for estimates of the economic benefits of health programs will vary according to the purpose of the analysis. In general, *consistency of approach* is the key for all programs that will be compared, whether they are intrasectoral comparisons of health programs or comparisons of health programs and other economic development programs.

Two extreme approaches are possible for the presentation of the estimated economic benefits. At the simplistic extreme, estimates of potential increases in total regional product are presented under the assumption that (1) all healthy days gained will be used productively at the prevailing rate of production and (2) all health care resources no longer needed to treat the specific health problem(s) will be used equally productively for other health programs or elsewhere in the economy. This approach ignores the effects of population changes and other measures of long-term effects, such as changes in life outlook or changes in savings rates or land availability (refer to Figure 3).

At the other extreme, short-term estimates are optimally adjusted to the characteristics of the local economy and household structure, which allows for changes in employment rates and marginal productivity due to changes of disease incidence in the population. In this ideal approach, estimates would also be adjusted for the reallocation of work between market and nonmarket production within the household. Finally, long-term effects would be estimated, which would allow for changes in population, human capital formation, and changes in other factors.

Between these two extremes are a range of other possibilities, the selection of which depends on the availability of data, or funds to collect data, and the methods used or available for estimating the economic benefits of other programs to which the health intervention will be compared.

The problem with the first approach to presenting economic benefits is that it is overly simplistic and unrealistic. The second approach, however, can also be criticized for being unrealistic and infeasible. So much data is needed to perform the analysis that compromises and assumptions will inevitably have to be made. The results may be very sensitive to the assumptions made, especially regarding long-term effects. Thus, an approach in between the two extremes described above is likely to be the outcome. In such an approach, the analyst must (1) be sensitive to the factors that reduce the gains in productivity estimated using the first, more simplistic approach and (2) avoid the dangers of attempting an excessively sophisticated approach when data or available resources will not support such an effort.

Further, if estimates of economic benefits are to have policy significance, they must (1) be presented in a credible manner; (2) show the current effects of the disease on the economy for the selected area, whether a specific region or the entire country; and (3) indicate the extent to which health programs designed to decrease the incidence of the disease(s) can be expected to offer economic return themselves in terms of regional or national gains in output.

Finally, it should be pointed out that the core-cost COI methodology omits critical aspects of the complete costs of a disease, both to the economy or society and to individuals. To the extent COI-specific results themselves are accurate, therefore, the estimates are conservative, underestimates, and understatements of the true costs. The costs to the economy are underestimates in excluding such factors as lost schooling. The costs to both society and individuals are understatements in that nonquantifiable effects, such as pain and suffering, are not included. Any presentation to policymakers on the costs of illness, therefore, should emphasize the potentially conservative nature of the results.

3

CONCLUSION AND NEXT STEPS

In this report, we have described the methodological and data problems associated with estimating the economic benefits of programs designed to improve health in developing countries. In particular, we have contrasted two methods for estimating such benefits: the macroproductivity, or COI, approach and the empirical approach. The COI approach has been criticized as being too simplistic and generating overestimates of productivity gains. We proposed a third approach, which might be referred to as a modified COI approach, whereby the traditional COI approach is modified by taking into account the various factors that might cause the COI approach to overestimate productivity gains.

It is beyond the scope of this study to propose a fully developed methodology for estimating the economic benefits from health programs. However, we described a series of steps that must be completed to perform such an analysis. This series of steps is intended to provide guidance for health policy decision makers in designing or performing an analysis of the economic benefits of a health program.

3.1 Unresolved Issue/Need for Further Research

One important area for future research is empirical measurement of the effects on economic productivity of programs having different effects on the distribution of disease severity. This would be a move away from the current dichotomous disease/no disease model. A program that has little effect on disease incidence but which changes the distribution from numerous severe cases (with severe economic impact) to an equal number of mild-to-moderate cases (with little or no economic impact) may be more desirable than a program that reduces incidence overall but leaves the same distribution of disease severity.

3.2 Recommendations for Elaboration of Approach

Elaborating or testing the approach described in this report should be done on a country- and disease-specific basis to test its feasibility and validity. There is obviously a need for a multidisciplinary approach, seeking input from epidemiologists, survey researchers/sampling statisticians, economists, and policy specialists to facilitate effective presentation of results. Moreover, the model relies on local input and expert opinion to fill many of the expected data gaps. This use of expert opinion implies close collaboration with local officials, which will have the side benefit of gaining their participation, involvement, and potential "investment" in the analysis and its results.

Conducting COI studies at the lowest level of decision-making authority for the disease/intervention under consideration will likely result in their having the greater impact because of the greater focus of the study. Finally, a more circumscribed area of study (i.e., national to regional to local) will likely result in fewer assumptions and less confounding variation from the overall economy.

Appendix A

REVIEW OF HEALTH BENEFITS STUDIES IN DEVELOPING COUNTRIES

In this appendix we briefly summarize the published reviews of the methodological and data issues and problems associated with estimating the economic benefits of health programs in developing countries We also present some examples of studies of health benefits that illustrate these issues and problems.

A1. Review of Methodological Issues

A1.1 Health as a Consumption and an Investment Good

Over the past two decades, economic analyses of the value of improvements in health have benefited from the framework proposed by Grossman (1972). In this framework, improvements in health are valued for their consumption and investment effects. As a consumption commodity, better health increases utility or well-being directly. As an investment commodity, better health increases the time available for work in the market and nonmarket sectors of the economy. Improvements in health also increase the return on investment in human capital.

In their review of economics, health, and tropical disease, Andreano and Helminiak (1986) divided the *consumption effects* of improved health into the following:

- Direct health consumption effects from reduced pain and suffering and an improved sense of well-being
- Indirect social interaction and leisure effects resulting from the reduced stress on the family unit

Their *investment effects* include three components:

- Short-term market and nonmarket production effects due to increased land and labor supply and reduced use of medical care resources
- Long-term production effects due to long-run changes in labor supply because of demographic effects

- Long-run changes in land supply, capital formation, investment in human capital, and community attitudes about risk and innovation

Andreano and Helminiak pointed out that, in practice, it is hard to value the consumption effects of health as well as the long-term production effects. For that reason, most studies that estimate the value of improvements in health only estimate the short-term production effects associated with reduced use of medical care resources and the increased labor supply, that is, the core components of the COI methodology.

A1.2 Valuing Avoided Treatment Costs

Many studies of the benefits of preventing or reducing the incidence of tropical diseases have included estimates of the avoided treatment costs (Dunlop 1984; Horton and Claquin 1983; Paul et al. 1986). Two important methodological issues arise when estimating treatment costs:

- What proportion of disease sufferers receive treatment?
- What is the value of resources no longer needed for disease treatment following a successful intervention?

Not all people who contract a disease will receive treatment. For some, the symptoms are so mild that treatment is not necessary. Others may not have access to treatment because of geographical, financial, or other (e.g., social) barriers. It should also be noted that in some cases effective treatment may not exist, or the belief patterns of those affected by the disease may preclude their availing themselves of the treatment. Avoided treatment costs are generally estimated as the average cost of treating each case of a disease, multiplied by the number of cases avoided. The way in which average costs are computed determines whether the proportion of cases currently receiving treatment is included in the estimation.

In general, economists value resources used in one sector as being equal to the opportunity cost of those resources, that is, their value in their next best use in the economy (Carrin 1984; Squire and van der Tak 1975). In a perfectly competitive labor market, moreover, wage rates will be equal to the opportunity cost of the marginal worker. However, in developing countries, as elsewhere, the labor market is not perfectly competitive, and wage rates often do not measure either the value of the marginal product of the marginal worker or the opportunity costs (Creese and Henderson 1980; Prescott and Warford 1983). In fact, the expectation is that wage rates for health care workers overestimate their opportunity costs. Conversely, the opportunity costs of imported goods, such as locally unavailable medical supplies and pharmaceutical products, may be higher than indicated by their price because of the scarcity of foreign exchange (Horton and Claquin 1983; Prescott and Warford 1983). These methodological problems are commonly resolved by computing shadow prices

that reflect the opportunity costs of labor and goods used in medical care (Creese and Henderson 1980; Horton and Claquin 1983; Squire and van der Tak 1975).

Horton and Claquin (1983) estimated the costs of treating a case of diarrhea in Bangladesh. Cost information was obtained from financial, supply, and worker time-use records and equipment logs at the treatment site. Labor costs had to be allocated between diarrhea treatment and other health services based on self-reported time allocations. Horton and Claquin estimated (1) the cost of treating one additional patient, mostly for drugs and food; (2) the annual costs of the treatment site divided by the number of patients treated, including drugs, food, wages, and rent; and (3) total average cost, which included the annual cost of resources tied up in equipment. The appropriate value to use to estimate the cost savings from reduced incidence of diarrhea depends on the size of the reduction and whether long- or short-term estimates of cost savings are desired. Readily available shadow exchange rates were used to convert the prices of imported goods, such as fuel and equipment, into the local currency. Shadow wages were not used to adjust the actual wage rates to represent true opportunity costs because of the difficulty of estimating a shadow wage rate.

If the problems of differential severity of cases and differential access are ignored, avoided treatment costs can be estimated as the product of the cost of treating a typical case of the disease and the estimated number of cases avoided. The problems of differential severity and access could be accounted for in the measurement of avoided treatment costs by estimating the distribution of severity of cases before and after the health program, as well as the number of cases. In addition, treatment costs for each level of severity and the number of people seeking treatment at each level of severity could be estimated in different subpopulations. These estimates could then be used to generate more realistic estimates of the avoided treatment costs under current conditions. Sensitivity analysis could be performed to determine what the avoided treatment costs would be if all people had access to treatment.

A1.3 Valuing Productivity Gains for All Household Labor

Andreano and Helminiak (1986) listed the following possible productivity gains associated with improvements in health:

- Higher labor productivity
- Higher total output
- Increased stock of capital, which enhances efficient use of capital

According to these authors, the gains are likely to be observed when health improves, for several reasons, including the following:

- Decreased absenteeism from work
- Improved mental and physical capacity of adults and children
- Lengthening of working lives
- Reduced household resources used to care for the sick
- Reduced resources used to avoid illness
- Improved fertility
- Lowered child mortality

Two methods have been used to measure the short-term gains in productivity attributable to the factors listed above. The first and traditional method, the macroproductivity approach, estimates the increases in working days attributable to the health program for each individual in the household and multiplies the increased working days by the average wage rate or marginal productivity in the regional economy. The second method, the empirical approach, uses survey data and regression analysis to determine the relationship between disease and observed productivity.

A1.3.1 Macroproductivity Estimates

To illustrate the essential steps of the traditional method for estimating productivity gains from health programs, we briefly review three studies that estimate, respectively,

1. Changes in disease incidence and fatality rates as a result of a specific health program
2. Changes in healthy days associated with a case of a disease
3. Changes in productivity as a result of a health program

The first study, a survey analysis of the literature performed for the WASH Project by Esrey et al. (1990), reviewed and analyzed the findings of a number of studies of the impact of improved water supply and sanitation on six diseases: diarrheal diseases, ascariasis, guinea worm, hookworm, schistosomiasis, and trachoma. A total of 142 studies were reviewed, of which 42 were determined to be "better" studies on the basis of methodological rigor. Median reductions in disease morbidity ranged from 27 percent (trachoma) to 78 percent (guinea

worm) for the better studies. Table A-1 provides a summary of the expected reductions in diseases from water supply interventions, that is, evidence for the intervention-health status linkage, from the Esrey et al. study.

Table A-1

Expected Reduction in Diseases

	All Studies			Better Studies		
	No.	Median	Range	No.	Median	Range
Diarrheal morbidity	55	26%	0-100%	20	29%	0-68%
Ascariasis	11	28%	0-70%	4	29%	15-70%
Guinea worm	7	76%	37-98%	2	78%	75-81%
Hookworm	9	4%	0-100%	—	—	—
Schistosomiasis	4	73%	59-87%	3	77%	59-87%
Trachoma	13	50%	0-91%	7	27%	10-79%

SOURCE: Esrey et al. (1990)

In their analysis of current research, Esrey et al. concluded that broad health impacts affecting all age groups can be expected from improvements in water supply and sanitation. They also found that reductions in disease severity were larger than reductions in disease incidence, but they did not quantify the level of those effects in their report.

In the second study, a team of researchers developed estimates of the days of healthy life lost for 48 diseases that are major causes of illness or death in Ghana (Ghana Health Project Assessment Team 1981; Morrow 1984). They postulated that a disease has three effects: illness, disability, and death. Each of these is measured as losses in days of healthy life so that the three effects can be added for each disease. The data they used came from census data, including derived estimates of age-specific death rates and life tables; cause of death, as recorded on death certificates; inpatient and outpatient statistics; and data from special surveys and studies. Using these data, they estimated the following for each disease:

- Incidence
- Case fatality rate
- Average ages at onset and death from the disease

- Expectation of years of life at those ages
- Extent and duration of illness and disability among those attacked by the disease

They combined this information to estimate the average number of days of healthy life lost to the community by each patient with the disease and the total number of days lost by the community attributable to the disease.

From the perspective of the effects of disease on the economy, there are several problems with this method of estimating disease effects, apart from the major problem of lack of data. One of the problems is the lack of consideration of the effect of multiple diseases or other environmental factors on the impact of a single disease. In the Ghana study, care was taken to not double count deaths; only one primary cause of death was allowed. It was not so easy, however, for the researchers to assign illness and disability days to different diseases, and they did not describe the method they used. It is also likely that case fatality rates, as well as severity of illness and disability, will vary according to the general health and nutritional status of the individual. Thus, the effects of a specific disease may vary among different subpopulations in Ghana depending on other health and environmental factors. The benefits of a program to control the 48 diseases would therefore also vary among the subpopulations.

One way to extend the Ghana analysis would be to subdivide diseases into different levels of severity (e.g., Prescott, 1979, subdivided schistosomiasis into asymptomatic, mild, moderate, severe, and very severe) and to estimate the healthy days lost for each level of severity. The effect of the disease on a particular community could then be estimated if the distribution of levels of severity of the disease in that population is known or could be estimated from a knowledge of their health and nutritional status.

Another problem with this analysis from the perspective of health benefits analysis is that no distinction was made in the ages at which the healthy life was lost. Clearly, childhood illness has different effects on productivity than adult illness. Prescott et al. (1984) and Bamum (1987) have proposed using estimates of healthy days lost during productive ages only in order to derive estimates of the negative effects on productivity from disease.

Alternatively, weights could be applied to healthy days lost at each age. The weight for the child ages would reflect the productivity losses for care givers. In most households a certain proportion of children who die are replaced by additional births and therefore healthy days of life lost from particular child deaths may be overestimates of the long-term losses to the household. Otherwise, estimating projected economic productivity for children who have survived as the result of an intervention is problematic due to the relatively unknown scale and impact of unemployment and underemployment 10, 15, or more years in the future. Finally, both Prescott et al. (1984) and Bamum (1987) proposed the use of social discount rates to adjust the estimates according to the timing of the disease effects.

The third study (Paul et al. 1986) was prepared under a WASH activity and illustrates how estimates of reduced disease incidence are converted first to gains in healthy days and then to gains in productivity, using the COI approach. As part of the analysis, avoided health care costs and improved agricultural productivity associated with a guinea worm control program in Pakistan were estimated using a human capital approach. Demographic, health, and agricultural productivity information was obtained from local and national sources, including the following:

- Estimates of disease incidence, from special-purpose epidemiologic surveys of the disease
- Relative effectiveness of interventions, from the program itself
- Costs (and availability) of treatment, from the Ministry of Health
- Population data, from the Census Office
- Agricultural productivity measures, based on data from the Ministry of Agriculture

Interpretation and analysis of these data were also based extensively on the knowledge of experts familiar with the guinea worm-affected areas.

Because of the unusual and unique characteristics of guinea worm disease, many simplifying assumptions were proposed as appropriate in this study. Critical among the assumptions were the following:

- Incidence for guinea worm disease is the same as prevalence because the disease occurs on an annual cycle with new infections each year and no acquired immunity.
- Symptoms of the disease almost always coincide with the agricultural season and effectively remove all afflicted individuals from participation in agricultural activities for that whole season.
- Mortality from the infection is rare, and recovery is normal; permanent disability occurs in a small percentage of cases.
- Guinea worm disease only occurs in the poorest of areas where there is little economically productive activity other than agriculture.

Estimates of gains in economic productivity from guinea worm eradication programs in the affected areas in Pakistan were thus derived as the product of per capita agricultural

productivity and the reduced incidence of the disease expected as a result of the health programs. It was also assumed that there was no surplus labor to substitute for the guinea worm-disabled person. In the remote and impoverished regions where guinea worm disease occurs, agricultural and household labor were assumed to be interchangeable, and no difference was assumed regarding their value. This is in fact similar to the opportunity cost approach to household labor used in many traditional COI studies.

Agricultural losses were projected into the future at the same level, and net present values were calculated using differing discount rates. Different scenarios were also tested as part of the sensitivity analysis, based on different assumptions regarding implementation of guinea worm disease programs and program effectiveness.

Although considered to be appropriate for the situation of guinea worm eradication, this general COI approach to estimating the productivity gains for health interventions in developing countries has been subjected to much criticism. For example, in a review of studies of productivity losses associated with schistosomiasis, Prescott (1979) identified several problems:

- The effect of the disease on healthy days is assumed and not estimated in most studies.
- The effect of the disease is assumed to be the same for all infected persons, and no adjustment is made for the severity of the infection or interactions with concurrent parasitic infections and malnutrition.
- No difference in the effect of the disease on productivity is estimated for different types of occupation.
- The number of workers infected with the disease is often assumed equal to the number of cases, which ignores the fact that not all members of the population are employed.
- The studies only account for output gains from increased time worked and do not account for a possible increase in productivity for each unit of time worked for healthier workers.
- Minimum wages are unlikely to be equal to the value of the marginal product of labor because agricultural markets are imperfect.

One final problem when using the macroproductivity method is that the wage rates or marginal products when healthy of those currently sick are not necessarily equal to the wage rates of those currently well. They could be higher or lower depending on who gets sick and why. In addition, this method assumes that all the gains in working days can and will be

spent working. No account is taken of possibly limited job opportunities or unemployment, and no account is taken of possible household choice to spend the additional healthy time in home production that is not measured by the researcher, such as child care or leisure (Popkin 1982).

A1.3.2 Empirical Estimates

The alternative method for estimating short-term productivity changes requires direct study and data collection in the affected area, followed by estimation of the relationship between actual productivity and the presence or absence of disease. When using empirical methods, survey data are used to estimate productivity as measured by weekly earnings, number of days worked, and daily earnings, for those with different levels of severity of the disease of interest. Other factors that might affect productivity can be controlled for during the analysis.

An example of such estimates comes from a large-scale and very thorough empirical investigation of the effects of schistosomiasis on rural banana estate workers and urban light manufacturing workers that was carried out by Weisbrod et al. (1973) in St. Lucia from 1967 to 1969. They estimated the effects of schistosomiasis on the following:

- Weekly earnings
- Type of job
- Productivity per day worked
- Labor time supplied per week

They performed multiple regression analyses using data on individual characteristics from the following sources:

- A household survey
- A work-site questionnaire
- Estate records on worker attendance, physical output, and earnings
- Infection data measuring both presence and intensity (i.e., egg load) of infection

The results of the study showed that schistosomiasis had no significant effect on weekly earnings of either males or females. However, it was associated with lower daily productivity for males, offset by greater average days worked per week by infected workers. The latter result suggests that infected male workers compensated for their reduced daily productivity

by working relatively more days in order to maintain earnings. There were no significant productivity effects for the females in the urban plant in St. Lucia.

The intensity of infection with schistosomiasis in St. Lucia was thought to be only moderate, which may account for its apparent lack of effect on productivity. In addition, the study made no attempt to measure home-produced commodities, either those that might be sold or those produced for home consumption only, such as child care or leisure. The study also did not estimate the effects of schistosomiasis on labor force participation. The study did test the effect of schistosomiasis infection on school performance, but here again the results were not significant.

Other empirical studies similar to that of Weisbrod et al. have produced conflicting results as to the effect of schistosomiasis on productivity. Foster (1967) found no effect for cane cutters but reduced days of work for irrigation workers in Tanzania. Fenwick and Figenschou (1972), on the same estate in Tanzania, found significant earnings differences between infected and uninfected workers in a cross-sectional study. In a time-series study, they found that productivity of workers receiving chemotherapy was increased. On the other hand, Gateff et al. (1971) did not find any effects in Cameroon. Finally, a study in Brazil by Barbosa and Pereira de Costa (1981) found a significant effect on productivity for severely affected workers.

Popkin (1982) has proposed an alternative approach to that commonly used to measure the effect of a change in disease incidence on an individual's productive output. He suggests that a more appropriate approach would be to focus on production, consumption, and investment at the household, instead of individual, level. Households produce commodities that add to their well-being. Home-produced and -consumed commodities include shelter, child care, nutrition, health, and leisure. In Popkin's "household framework," these commodities are produced using inputs of household time and market commodities. Household time is also allocated to market work in order to earn money to buy the market commodities needed for home production. Households allocate their time between home production and market work in such a way as to maximize their well-being. When one or more family members become sick, other household members will reallocate their time. They may reduce time spent in home production of leisure and child care while maintaining the time spent in market production, if that is possible. The changes in time allocations will depend on the initial allocations of time and the substitutability of labor, which will vary between regions and population subgroups.

A limitation of Popkin's approach is that it must be applied on a population-by-population basis and requires extensive survey data collection. Additionally, units of measurement have to be derived for measuring nonmarket home production. However, it does have the potential for generating estimates of the full effects on the household of health programs.

The most complete empirical analysis of the effect of disease on household productivity is the study of malaria in Paraguay undertaken by Conly (1976). Data on the farming activities of 69 farming families in eastern Paraguay were collected over 20 months. The families were subdivided into three groups according to whether they were much, moderately, or little affected by malaria. The 12 "much malaria" families appear to have been substantially affected. Unlike most other productivity impact studies, Conly's was not restricted to market production; it extended instead to the cash and noncash agricultural production of families. The study suggests that malaria-affected families stressed the production of their cash crops at the expense of nonmarket production. Conly noted intrafamily adjustments to illness, such as children being taken out of school, in an attempt to maintain agricultural production. Thus, Conly's study suggests that one explanation for the generally insignificant results of the empirical schistosomiasis studies could be that they measured cash production only and that this is maintained at the expense of home production when illness is present.

The empirical method can estimate productivity for either a single individual (e.g., Weisbrod et al. 1973) or for a household unit (e.g., Conly 1976). If the individual is the unit of analysis, any changes in productivity that result from substitution of labor within the household will not be accounted for. The degree to which persons within a household can substitute for one another depends on the type of market and nonmarket economy in the community. For example, substitution is easier in a farm economy than in a nonfarm economy, such as mining or manufacturing.

The main advantage of the empirical method is that the estimates of productivity losses are much more likely to be realistic than those obtained using the traditional macroproductivity approach. The main disadvantages are that detailed and difficult data collection is required for each area of interest and the results cannot be generalized to nonsurveyed areas.

Researchers using either method generally make simplifying assumptions about unemployment rates. They generally assume that unemployment is not affected by the change in health status of the population as a whole and associated increases in labor supply. For small changes in a region's incidence of disease, such an assumption might be valid. For larger changes in disease incidence, this assumption can only be true if there is a shortage of labor because of excess capital. Adjustments could be made to allow for such changes as an increase in the pool of healthy labor, but the Barlow (1967) simulation model for Sri Lanka is the only study in which such changes have been explicitly included in the health benefits analysis.

A1.4 Possible Macroeconomic Long-Term Effects

If large changes in disease incidence occur in a region, there are likely to be long-term effects, which may differ in direction or intensity from the short-term effects. These long-term effects occur because of changes in one or more of the following:

- Population size and age distribution
- Land supply
- Stock of human capital
- Savings ratio
- Capital/labor ratios
- Patterns of consumer demand
- Prices of goods
- Value of the marginal product of labor
- Household or individual attitude to innovation and risk taking

Although many researchers acknowledge that changes in disease incidence may have long-run effects on the economy that cannot be captured by the types of cross-sectional analyses that we have described above, only one comprehensive model of the economic impact of a health program has been developed, Barlow's (1967) model of the effects of malaria eradication in Sri Lanka. Barlow simulated per capita income in Sri Lanka during the 30 years following eradication, assuming eradication had not occurred, and compared the results with the actual observed values. He assumed that capital formation is directly determined by the amount of public and private savings and that labor inputs are expanded because of an increased working-age population resulting from reduced mortality and increased fertility and because of decreased morbidity and debility among the work force. The results of his simulation showed that a positive productivity effect of increased labor input due to eradication dominated population growth over the first eight years, but after that, growth in population exceeded growth in income. This was because, in Barlow's model, malaria eradication expanded the total population more rapidly than the work force and caused public noninvestment expenditure to grow faster than investment capital formation. Over the long term, per capita income was found to be lower in year 30 with eradication than it would have been without.

This study is the only truly long-term macroeconomic study of the economic effects of a health intervention. The most obvious reason for its uniqueness is the enormous quantity of data required for its implementation and the complexity of the macroeconomic model. Since, inevitably some of the data would not be available, values would have to be assumed. Over the long time periods of the model, the results would be likely to be sensitive to the data assumptions and assumed model structure and, therefore, lack credibility. The study does, however, illustrate an important point that has not generally been discussed in the reviews

of health benefits studies. Is the appropriate measure of economic well-being for a region or country its total output (gross domestic product) or the per capita output? Most studies have been concerned with estimating total output only and have not considered per capita output questions, largely because the studies are limited to the short run.

Ram and Schultz (1979) reviewed the literature relating population growth due to lower death rates to economic development. In their review they summarized studies that conclude, like Barlow, that population growth will slow economic development because of reduced public investment in physical capital. This reduced investment comes about as a result of the increased need for public expenditure on schools, health, and other social programs. Ram and Schultz pointed out that these analyses omit measurement of likely increased investment in human capital that occurs as life expectancy is increased. The studies generally also omit measuring the effect on output of the increased productivity of healthier workers. Further, a younger population may be more open to innovation and technical change. Thus, the marginal productivity of labor will not necessarily decrease with increased population, and income per capita will not necessarily fall.

Finally, when looking at the long-range effects of health programs, one must choose a suitable discount rate. There is general agreement that health benefits that are experienced sooner are more valued than those that occur later. However, there is no consensus as to the correct rate for discounting future benefits (Barnum 1987). Controversy exists between selecting a higher rate, which more accurately represents the opportunity cost of capital ("efficiency pricing"), or a lower rate, which might reflect the social rate of time preference. Sensitivity analysis to test the range of plausible discount rates is desirable. The choice of a discount rate is particularly important in cases in which initial economic benefits from a health program may be followed after several years by adverse effects on the economy because of long-term demographic effects (Barlow 1967), or when the stream of benefits from a health intervention continues unabated because of successful disease eradication (Paul 1988).

Clearly, it is important, if estimates are to be credible to planners and policymakers, to be able to estimate the long-term effects of health programs on per capita income. However, the Barlow model alone is probably too complex and its data requirements are too heavy to be practical. We suggest the development of a simpler model of long-term effects whereby macroeconomic parameter estimates are assumed or estimated rather than generated within the model. The advantage of such a simulation approach is that the assumptions can be changed in a sensitivity analysis and a range of possible estimates obtained.

A2. Review of Data Issues

In the previous section, we summarized many of the methodological issues and significant problems when performing studies to estimate the economic benefits of health programs. In this section, we summarize the data issues and problems.

A2.1 Data Needs and Sources

The data that are needed to estimate the effect of a health program on the economy of a region include the following:

- Estimates of the current effect of the health problem(s) of interest on the health, well-being, productivity, and school attendance of the population
- Current use and cost of health care services for the health problem(s)
- Information on the type of economy in the region, the current employment patterns of labor, and the current and future availability of physical capital

A typical COI study in the United States might use data from health interview surveys, hospital discharge surveys, cause-specific mortality tables, national surveys on health care costs and disability by disease, and national surveys on average wage rates (Policy Analysis Inc. 1981; Salkever 1985). The U.S.-based COI studies typically assume that markets are perfect and thus wage rates are equal to the opportunity cost of labor. They also assume full employment and ignore the problem of multiple causes of death or disability (Tolley et al. 1978). Further, they ignore differing environmental factors for different segments of the population, which might affect the severity of the disease or the response to treatment.

In developing countries, however, data availability and the analytic environment are very different. National and regional statistics on births and deaths are generally available. If they are not, other techniques developed by demographers can be used to derive them, given some knowledge about the age distribution of the population (see, e.g., Cohen 1974). Cause-specific mortality rates may also be available. However, because of the existence of centralized national health systems in most developing countries, data on health care costs and utilization are much more problematic to obtain or estimate. Finally, data will often be available on employment and productivity in some, but not all, sectors of the economy, but it is unlikely that there will be adequate national or regional data on days lost from work because of sickness.

Cohen (1974) estimated the economic benefits of eliminating mortality due to schistosomiasis in Zanzibar using published, but generally inadequate, epidemiologic, demographic, and economic data. We review how he derived the data needed for the study to illustrate the data issues discussed above.

In order to estimate the death rate from schistosomiasis, Cohen used the results from a study by Forsyth (1969) of stool and urine specimens of 1,004 people in Zanzibar over a two-year period. During this period, 22 people died. Four of the 19 deaths of people over 20 years of age were attributed to schistosomiasis because kidney failure was given as the cause of death. Although schistosomiasis can cause kidney failure, Forsyth did not cross-tabulate data on infection with data on kidney failure, and thus, it is possible that the kidney failure was from other causes. Edington (1957) found that fewer than half the deaths from renal failure were attributable to schistosomiasis in Ghana. In addition, Forsyth did not say how he chose the community to sample, so that it may not be representative of Zanzibar as a whole. Despite these and other criticisms of the Forsyth study, Cohen used the schistosomiasis death rate from that study in his analysis.

No life tables were available for Zanzibar in 1974. However, it is possible to estimate a life table using the theory of stable populations. Cohen used the Brass technique (Brass et al. 1968) to derive a life table from available census data. He adjusted the stable population assumption to reflect a declining mortality rate for Zanzibar. He then compared the age distribution predicted by this technique with the age distribution recorded by Forsyth. Once he had estimated the life table, he used the technique described in Spiegelman (1968) and Forsyth's data to estimate the life table that would obtain if schistosomiasis was eliminated. From these estimates, he could estimate additional years of life in the absence of schistosomiasis.

Cohen stated that economic statistics for Zanzibar were even scarcer than demographic statistics. He found qualitative descriptions in the International Labor Office and scattered sources from publications while Zanzibar was still a protectorate. He assumed the percentage of males economically active to be 100 percent for all males between the ages of 15 and 60, based on a United Nations report and the age distribution of the population, and defined "economically active" as working during some part of the year. Finally, he estimated average annual earnings for unskilled labor as a lower bound using three data sources: a United Kingdom Colonial Office report; a Labour Department report; and a East African Common Services Organization report.

This description of the data sources used by Cohen in Zanzibar illustrates that sufficient data will usually be available as a basis for the needed parameter estimates. The problem is that such estimates are associated with uncertainty and may be biased up or down. The ranking of the benefits for different development programs will depend on the data sources available and may be sensitive to their biases.

In addition to the possible scarcity of national or regional data on health, health care costs and utilization, and employment, there is unlikely to be detailed information on the disparities in environmental factors among different segments of the population. Examples of environmental factors of importance are the presence of multiple endemic diseases and the lack of adequate nutrition or water supply and sanitation for some population subgroups. Information about these factors, however, may be available from national or regional sources or local experts.

Political and legal constraints may also affect the health or productivity changes associated with a health program. Examples of institutional factors of importance include legal restrictions on land ownership and political barriers to relocation.

Neither in the United States nor in developing countries are data typically available that measure the amount or value of the nonmarket commodities produced by the household. Such nonmarket commodities include nutrition, health, child care, and leisure and may be of greater importance in developing countries than in the United States. Household surveys are the only way to collect such data, and they are expensive and hard to generalize from one area to another. Popkin (1982), however, has suggested a general framework for such surveys, which is shown in Table A-2.

A3. Summary of Problems When Estimating Economic Impacts of Health Programs

In reviewing selected health benefits studies, we have identified many of the issues and problems that make estimates of the economic benefits from health programs at best an approximation of reality. This section summarizes the problems that are likely to remain, even after careful consideration of the foregoing issues and problems.

A3.1 Methodological Problems

The empirical approach to estimating productivity gains from health programs gives more realistic estimates, but it is expensive to apply and the results from one study cannot readily be generalized. The macroproductivity, or COI, approach is a general method for estimating productivity losses, whereby productivity losses are estimated as the product of days lost to illness and the average daily wage. Very often this approach does not account for differences in the allocation of time within healthy and unhealthy families and differences in employment opportunities in different communities. Both of these factors will affect the productivity gains from better health. The problem for those wishing to use the macroproductivity (COI) approach to estimate productivity changes is that the relationship between health and the allocation of household time to market and nonmarket activities is not well understood and

Table A-2

Multipurpose Data Desirable for Analyzing the Social and Economic Impact of Tropical Diseases

Household and Individual Data

Demographic, social:
Age/sex composition; educational attainment; resident duration and origins; current school attendance; pregnancy and fertility histories (detailed for recent period); other factors that can affect fertility and mortality (e.g., family planning, breastfeeding).

Wealth assets:
Ownership of housing, land, various economic and household items; debt profile; land tenure status.

Economic activities (farming/livestock/fishing/business/wage labor):
For each major activity, detailed inputs (materials, labor, assets...) and outputs; include market and opportunity costs for labor and other items.

Unearned income:
Sources of income or cash from rent, gifts, remittances, and others.

Time allocation:
For a selected reference period: complete time use by each family member in home and market activities.

Health service use:
Curative and preventive use of traditional and modern personnel and facilities and related factors (distance, expenditures, insurance, etc.).

Knowledge/beliefs/attitudes:
Those related to key diseases of interest and use of important services (e.g., vaccination, sanitation, water, modern medicine).

Health status:
General (e.g., anthropometry) and specific (e.g., spleen, stools for each individual; also medical histories of acute and chronic problems).

Selected historical data:
Work experience, seasonal migration, travel to infested areas, etc.

Community Data

Infrastructure:
Information on sanitation, water and related services, roads, transportation, irrigation.

Services:
Social service availability (distance and travel time and cost of facilities and personnel); visits to community services for education, welfare, agriculture, health, family planning, and others.

Workers:
Knowledge, attitudes, and practices of workers who are crucial to activities affected by or which affect tropical diseases.

SOURCE: Popkin (1982).

likely to depend on the organization of the community, market production opportunities, and environmental factors. In addition, differences in employment opportunities and the availability of capital may critically affect productivity losses from disease and gains if disease incidence is reduced. The effects of employment opportunities will vary according to the organization of the community, type of employment, and environmental factors.

Finally, there remain other significant methodological questions when modeling the long-term economic effects of health programs. Some examples follow:

- The effect of reduced child mortality on fertility rates–in general, fertility rates will decline as child mortality rates decline, although there may be a lag of a number of years
- The effect of decreased adult morbidity on fertility rates
- The change in household receptivity to innovative ideas and the perception of the importance of investment in human capital under different disease/health scenarios

A3.2 Data Problems

The most obvious data problem is the high cost of collecting the type of data that are needed to obtain realistic estimates of the economic effects of health programs. Use of existing data is hampered by the need to access multiple and perhaps inconsistent or conflicting sources and the often unverified levels of validity and reliability of the data. Further, because of the complexity of the relationship between improvements in health and economic development, and the number of variables that affect it, data collected in one region often cannot readily be applied to another region. Because of imperfections in markets, it is also difficult to estimate the opportunity cost of labor and resources, that is, their values in their next best uses. Other difficulties include obtaining information on the following:

- Characteristics of individuals that are unknown to the researcher, such as genetic predispositions to different diseases or greater ability to tolerate disease
- Characteristics of the environment that are unknown or their effects not well understood, such as the presence of multiple diseases and the climate
- Behavioral and motivational characteristics of the population for which there are no convenient units of measurement

Finally, nonmarket production is hard to measure in any case, especially for things like child care and leisure, for which there are also no obvious units of measurement. Similarly, there is no metric for measuring possible long-term motivational and receptivity-to-innovation effects that may result from changes in life expectancy or morbidity/disability expectancy.

A4. Conclusions

In this appendix, we have reviewed selected studies to illustrate how health benefits have been estimated despite methodological and data problems. However, problems that arise when estimating the economic benefits of improvements in health have resulted in uncertainty about the accuracy of the results and, thus, a low level of credibility for this type of analysis. Nevertheless, if health programs are to compete for scarce resources with other types of economic development programs, such analyses must be done. Our proposed approach is to perform health benefits analyses that come as close as possible to the ideal, given available data and resources, and to estimate quantitatively or qualitatively the sensitivity of the results to assumptions made as a result of methodological and data problems that could not be solved.

Appendix B

TABLE SHELLS ILLUSTRATING TYPES AND FORMATS OF DATA NEEDED

Table B-1

Table Shell for Data on Short-Term Health Effects*
Part I: Incidence, Prevalence, and Mortality from Disease

Level of Severity**	Incidence New Cases/10,000/Year		Prevalence per 10,000		Mortality per 10,000/Year	
	With Program	Without Program	With Program	Without Program	With Program	Without Program
Mild cases (__% of all cases)						
Moderate cases (__% of all cases)						
Severe cases (__% of all cases)						
All cases						

*Separate values for each age and sex, if different.
**Mild, moderate, severe cases must be defined for each disease based on symptoms, prognosis, and treatment.

Table B-2

Table Shell for Data on Short-Term Health Effects*
Part II: Number of Days** at Each Level of Disability

	Level of Disability				
Level of Severity	None	Minor	Partial	Total	Total Duration of Illness until Cure or Death (years)
Mild					
Moderate					
Severe					

*Separate values for each age and sex if different.
**Either in 365 days/year or separate values to account for seasonality, if appropriate.

Table B-3

Table Shell for Data on Projecting Long-Term Health Effects

Time from Program Implementation	Multiple of Year 1 Fertility Rate	Multiple of Year 1 Population Size	Age Distribution of Population			
			0-5	6-15	16-15	51+
1 year	1	1				
11 years						
21 years						
31 years						
41 years						
51 years						

Table B-4

Table Shell for Data on Direct Costs of Treating Disease
Part I: Number of Hospital Days and Outpatient Visits

Level of Severity	Proportion Desiring Treatment	Proportion with Access to Treatment	Number of Hospital Days	Number of Outpatient Visits
Mild				
Moderate				
Severe				

Table B-5

Table Shell for Data on Direct Costs of Treating Disease
Part II: Resource Use per Hospital Day

Level of Severity	Fixed: Accommodation* (dollars)	"Semi-Fixed"				Variable	
		MD** (hours/dollars)	RN** (hours/dollars)	Aide** (hours/dollars)	Other Labor (hours/dollars)	Drugs*** (dollars)	Supplies*** (dollars)
Mild							
Moderate							
Severe							

*Cost = (proportion of days in regular care x unit cost of regular care facilities) + (proportion of days in intensive care x unit cost of intensive care facilities). Unit costs include building and equipment, maintenance, and operating costs other than MD, RN or Aide time.
**Cost = hours x wage rates or value of time in alternative use.
***Cost = drug or supply units x unit cost of drug or supply (possibly weighted upward for imported products).

Table B-6

Table Shell for Data for Estimating Direct Costs of Treating Disease
Part III: Resource Use per Outpatient Visit

Level of Severity	Fixed: Examining Rooms/Clinic* (dollars)	"Semi-Fixed"				Variable	
		MD** (hours/dollars)	RN** (hours/dollars)	Aide** (hours/dollars)	Other Labor (hours/dollars)	Drugs*** (dollars)	Supplies*** (dollars)
Mild							
Moderate							
Severe							

*Cost = unit cost of clinic and examining room facilities, including building, equipment, and maintenance and operating costs but not including MD, RN, or Aide time.
**Cost = hours x wage rates or value of time in alternative use.
***Cost = drug or supply units x unit cost of drug or supply (possibly weighted upward for imported products).

Table B-7

Table Shell for Data on Maximum Productivity Gains

Season	Production of Market Goods per Day*		Production of Nonmarket Goods per Day**	
	Quantity	Dollars	Quantity	Dollars
Rainy season***				
Dry season***				

*Values for individuals by sex and age group or by household for agricultural and/or nonagricultural production.
**May omit nonmarket goods from analysis.
***Other seasonality divisions.

Table B-8

Table Shell for Data on Adjustments to Maximum Productivity Gains

Season and Type of Product	Employment Descriptor*	New Capital Descriptor**	Substitutability of Labor Descriptor***
Rainy season			
Market			
Nonmarket			
Dry season			
Market			
Nonmarket			

*1 = excess demand for labor or full employment
2 = low levels of unemployment/underemployment, small disease effects
3 = low levels of unemployment/underemployment, large disease effects
4 = high levels of unemployment/underemployment

**1 = no new capital available
2 = new capital available

***1 = labor easily substitutable
2 = Labor not easily substitutable

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